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Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities under RCRA (Resource Conservation and Recovery Act), Subtitle C, Section 3004. Financial Requirements: Interim Status Standards (40 CFR 265 Subpart H) (with addendum)

(U.S.) Environmental Protection Agency
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DRAFT GUIDANCE

STANDARDS APPLICABLE TO OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES UNDER RCRA, SUBTITLE C, SECTION 3004

Financial Requirements: Interim Status Standards (40 CFR 265, Subpart H)

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This guidance manual is intended to serve as a GUIDE to the types of cost categories and documentation that are appropriate to include in a closure and post-closure care cost estimate.

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PREFACE

Thi~~s~~e guidance manual was developed to accompany the May 19, 1980 Subpart H cost estimating interim status regulations and their technical amendments. Since this manual was prepared, additional Subpart G regulations which affect the cost estimating requirements were promulgated. Therefore, this manual does not necessarily reflect all the current requirements. The Agency is planning to update this manual to incorporate these additional requirements. In the meantime, however, an addendum has been included in this manual to clarify several points.

Thi~~s~~e manual is intended to serve as a guide to the types of cost categories and documentation that are appropriate to include in a closure and post-closure care cost estimate. The sample estimates contained in this document illustrate the format and level of detail that would be acceptable to the U.S. Environmental Protection Agency. They are not, however, intended to serve as sample forms required by the Agency. In addition, these sample cost estimates do not represent a typical facility and, as a result, some cost components may be inapplicable to certain facilities. Finally and most importantly, these sample cost estimates do not reflect actual cost estimates and cannot be used either as substitutes for facility-specific estimates or as evaluative screens. The U.S. EPA urges members of the regulated community to contact their State agency or EPA Regional Office to discuss the applicability of this guide to their facility and other facility-specific requirements.

SUBPART H ADDENDUM

p. 2-3 (Section 2.4), p. 32 (Section 3.5)
The regulations do not require that a contingency factor be included, although it is advisable to do so.

pp. 5-2, 3
6-4
The unit costs included in Chapters 5 and 6 are outdated and may not be representative of actual costs.

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ATTENTION

AS NOTED IN THE NTIS ANNOUNCEMENT, PORTIONS OF THIS REPORT ARE NOT LEGIBLE. HOWEVER, IT IS THE BEST REPRODUCTION AVAILABLE FROM THE COPY SENT TO NTIS.

1.0 INTRODUCTION

EPA has developed standards for financial requirements for owners or operators of hazardous waste facilities as part of the Interim Status Standards — Subpart H Financial Requirements. This guidance document covers only those portions of Subpart H promulgated on 19 May 1980 and the technical amendments to those regulations. These portions require the owner or operator to prepare cost estimates for closure and post-closure. At later dates, Subpart H will also contain final regulations covering liability requirements and financial assurance mechanisms.

The purpose of the cost estimation requirements is to determine the amount of financial assurance needed. These requirements are presented in 40 CFR §265.142 for closure and 40 CFR §265.144 for post-closure. Each of these sections contains a requirement for a written cost estimate available on the premises (40 CFR §265.142(a) and 40 CFR §265.144(a)), a requirement for revisions in the cost estimate whenever changes are made in the applicable plans (40 CFR §265.142(b) and 40 CFR §265.144(b)) and a requirement for annual adjustments in the closure and post-closure cost estimates to reflect inflation (40 CFR §265.142(c) and 40 CFR §265.144(c)). All owners or operators of hazardous waste facilities, except those facilities owned or operated by states and the federal government, must prepare closure cost estimates. All owners or operators of facilities in which hazardous wastes will remain after closure, except those facilities owned or operated by states and the federal government, must prepare a post-closure cost estimate. The closure cost estimates must be available on the premises on the effective date of these regulations, i.e., November 19, 1980, for those facilities not required to have a post-closure plan. Owners or operators of land disposal facilities, or facilities closed as such, will not be required to have their closure and post-closure cost estimates available until six months from the effective date of these regulations, i.e., May 19, 1981, because of the complexities involved in developing plans and estimates for these types of facilities.

The purpose of this document is to assist the Regional Offices in implementing those sections of the interim status regulations relevant to closure and post-closure cost estimates. Since the bases for the cost estimates are the closure and post-closure plans, this section should be read in association with the guidance for closure and post-closure plans. The remainder of this document is divided into eight sections: basic rules for the closure cost estimate; basic rules for the post-closure cost estimate; preparing and documenting the closure and post-closure cost estimates; adequacy of the closure cost estimate; adequacy of the post-closure cost estimate; revising the closure and post-closure cost estimates; adjusting the cost estimates to account for inflation; and sample cost estimates for various types of facilities. The emphasis throughout this document is upon interim status. This is particularly important to the sections on adequacy of cost estimates, which are designed for rapid review and inspection.

Sample cost estimates have been developed for several kinds of facilities in the final section of this document. The purpose of these samples is to illustrate the concepts involved in closure and post-closure cost estimates and the formats which might be appropriate. The samples are developed through a series of worksheets designed to illustrate an appropriate format for demonstrating the scope and nature of the activities involved and the key unit cost elements used in arriving at the final estimate. Closure and post-closure costs will be highly site-specific, and as a result, these worksheets should be viewed as only general guidance and are unlikely to be applicable in any specific case. In no case should the unit costs used in the samples be regarded as proper and accurate costs to be used in developing cost estimates.

2.0 BASIC RULES FOR THE CLOSURE COST ESTIMATE

In developing closure cost estimates for interim status, the following concepts should be used for guidance.

2.1 The closure cost estimate is based upon the methods described in the closure plan.

A cost estimate should be prepared for each activity or sub-activity listed in the closure plan. The cost estimate is based upon the activities, quantities and methods indicated in the closure plan. For example, a cost estimate should be prepared for treating, disposing or removing inventory. It must account for managing the maximum inventory expected as indicated in the closure plan. The method used for treating, disposing or removing the inventory would be identical to that indicated in the closure plan. For example, if the closure plan indicates managing 1000 tons of waste, of which 800 tons are to be disposed or treated on-site and 200 tons removed to an off-site TSDF, the cost estimate must include estimates for these respective costs.

2.2 "The estimate must equal the cost of closure at the point in the facility's operating life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan."*

The goal of the cost estimate is to ensure that if at any point in time a facility had to begin closure for reasons unrelated to a catastrophe at the site, the costs of the closure would not exceed the cost estimate. Thus, the conditions on which the cost estimate is predicated will probably differ significantly from anticipated conditions at the end of normal facility life with respect to amounts of undisposed or untreated wastes on-hand, status of processing equipment, and area of the facility in disturbed condition.

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*EPA Interim Status Standards, 40 CFR §265.142(a).

maximum inventory on-site should include the maximum normally expected on-site. This estimate should take account of any long-term cycle of inventory on-hand, and should take account of predictable events which may occur over the life of the facility, such as adverse weather conditions preventing normal activity at a landfill and "down time" to periodically rebrick the refractory of an incinerator. The initial estimate need not, however, include provisions for highly unusual contingencies unless they exist at the time the facility submits its initial cost estimate. For example, the cost estimate need not include provision for such unusual contingencies as the effects of the 50-year storm or the failure of a liner in a major trench calling for removal of all waste in that trench. If such events occur over the life of the facility and cause the original maximum inventory estimate to be exceeded, the owner or operator should revise the closure plan to reflect the current situation unless he can immediately correct the situation so that his original estimate of maximum inventory is not exceeded. In cases of doubt, the Regional Administrator's office should be contacted as to the advisability of revising the cost estimate. In no case, however, should the initial cost estimate list a maximum inventory less than that actually on-site. If normal operating procedures include steps which would reduce closure costs, such as dredging of an impoundment or capping portions of a landfill, it should be assumed that closure will occur just before these activities. Thus, in the closure cost estimate all costs associated with such procedures should be included. This assumption is to ensure adequate funds in the closure cost estimate for the situation of forced closure due to an unforeseen event such as business failure of the facility's owner or operator.

If experience shows that the initial cost estimate over- or underestimated the most expensive conditions likely to occur over the life of the facility, or if those conditions are no longer possible, then revisions may be made in the cost estimate as appropriate (see Section 7.0). For example, if late in the life of the facility the total

2.3 Cost estimates are to be based upon the operating costs to the owner or operator of carrying out the planned activities.

This means that in developing the cost estimate the owner's or operator's depreciation costs, capital recovery factors, and interest on debt need not be included as part of the costs. For example, capital recovery and depreciation factors for earth-moving equipment owned by the owner or operator and costs of land already owned need not be considered as part of the costs of disposing of inventory at a landfill. If equipment must be rented to complete closure activities, however, the costs of this rental must be part of the cost estimate. If the owner or operator plans to contract out a specific activity (e.g., sandblasting and steam-cleaning the equipment on-site, planting vegetation), the full costs of that contract would be the correct cost estimate.

2.4 The cost estimates should include all associated costs necessary to carry out closure procedures.

A cost estimate for a given activity must include all costs associated with this activity, including fully loaded labor costs (i.e., including fringe benefits and overhead), any costs of supervision, fuel and maintenance costs for the equipment used, administrative costs, and provisions for normal contingencies. Administrative costs include all costs associated with taxes and insurance, as well as costs of routine administration, paperwork and reporting. "Provisions for normal contingencies" means that the cost estimates should include a factor for unforeseen events that may increase costs, such as those routinely put into most initial cost estimates. Such contingencies include adverse weather and other unanticipated complications. Given the absence in the closure plan of detailed engineering designs, the uncertain nature of precise facility conditions at the time of closure, and the lack of provision for inflation during the closure period (which, in some cases, can be quite lengthy), the provision for contingencies should be generous. Standard engineering practice shows that in most cases a provision for contingencies could reasonably be expected to fall within the range of 15 to 25 percent. The lower end of the range is appropriate for smaller facilities which require a short closure period and have fewer uncertain variables. The higher end of the range accounts for larger facilities which may require extensive activities and a longer closure period, for which unusual weather conditions or uncertain decontamination needs could seriously affect the cost of closure.

A cost estimate for treating inventory in an incinerator would include fully loaded labor costs, supervision, maintenance, utilities, any chemicals and catalysts employed, administration, and provisions for contingencies. Although the cost estimate should include all of these cost elements, they need not be documented separately. Thus, for example, well documented unit costs for treating inventory are appropriate even if they do not include separate documentation for maintenance, utilities, or all energy costs. This point is further discussed in Section 4.0 and examples of an appropriate approach are shown in Section 9.0.

2.5 The cost estimates should be based upon costs in the year in which the estimate is prepared; there is no need to provide for inflation in developing the cost estimate, as this will be provided for in the adjustment procedure.

Costs should be based upon current costs. For practical purposes, this means costs within one year of the time of preparation of the cost estimate. There is no need to adjust data or cost estimates based upon data within the current year to the exact month for which the cost estimate is dated.

3.0 BASIC RULES FOR THE POST-CLOSURE COST ESTIMATE

In developing a post-closure cost estimate for interim status, the following concepts should be used for guidance.

3.1 A post-closure cost estimate must be prepared for all facilities at which hazardous wastes remain on-site after closure.

Post-closure cost estimates are required for landfills and surface impoundments and land treatment systems at which any hazardous wastes remain on-site following final closure. If an owner or operator of a surface impoundment originally plans to close it as a storage or treatment facility by removing all hazardous waste, but later decides to close it as a disposal facility, he must immediately prepare a post-closure plan for the facility. In similar fashion, if the owner or operator of a land treatment facility originally prepares a closure plan based on the assumption that treatment will render the waste non-hazardous but tests show this is not the case, he must immediately prepare a post-closure plan and cost estimate.

3.2 The post-closure cost estimate is based upon the methods described in the post-closure plan.

The post-closure cost estimate is based upon the activities, quantities, and methods indicated in the post-closure plan. A cost estimate should be prepared for each activity or sub-activity listed in the post-closure plan. For example, a cost estimate should be prepared to cover maintenance activities. It must reflect the methods to be used in the post-closure plan and the rates of fertilization, mowing, sprinkling, and other activities listed in the post-closure plan.

3.3 The post-closure cost estimate should be prepared for the entire area expected to contain hazardous waste at the time of final closure.

The post-closure estimate should provide for post-closure care for the entire facility as it is expected to exist at the time of final closure. Thus, if a 180-acre facility is expected to be filled at a rate of 10 acres per year, the initial post-closure cost estimate must reflect the costs of post-closure care for the full 180 acres.

3.4 The post-closure cost estimate should reflect the costs of purchasing all necessary labor, materials and equipment to carry out post-closure requirements. Unlike the closure cost estimate, it may not be assumed that the owner or operator already has adequate equipment for the purpose.

It is highly uncertain whether the entire period of post-closure care will be carried out by the owner or operator himself, and whether on-site labor and equipment will be available. Therefore, the cost estimate should assume that all services required for post-closure must be contracted for in order to ensure financial adequacy. The post-closure cost estimate must therefore include adequate allowance for profits on the post-closure care services. For example, if regular mowing is part of the post-closure plan, the costs must reflect the costs of hiring a service to carry out this mowing, rather than the cost of having a laborer of the owner or operator using mowing equipment already in use elsewhere by the owner or operator. Similarly, monitoring costs must be estimated assuming it is necessary to hire outside help both to take the necessary samples and to conduct the necessary laboratory tests.

3.5 The post-closure cost estimate must be complete and include all associated costs necessary to carry out post-closure procedures.

A cost estimate for a given activity must include all costs associated with this activity, including fully loaded labor costs, any costs of supervision, fuel and maintenance costs for equipment used, administrative costs, and provisions for normal contingencies. Administrative costs include all costs associated with taxes and insurance, as well as costs of routine administration, paperwork and reporting. "Provisions for normal contingencies" means that the cost estimates should include a factor for unforeseen events that may increase costs, such as those routinely put into most initial cost estimates. Such contingencies include adverse weather and other unanticipated complications. Given the absence in the post-closure plan of detailed engineering designs, the uncertain nature of precise facility conditions at the time of post-closure, and the uncertainty of the kinds of maintenance to be required during the post-closure period, the provision for contingencies should be generous. Standard engineering practice shows that the provision for contingencies could reasonably be expected to fall within the range of 15 to 25 percent. As with closure costs, the documentation for the cost estimate need not break out all of these headings separately; they must, however, be included in any unit or activity cost estimates (see Sections 4.0 and 9.0). It is particularly important in the case of post-closure care to include supervision and inspection requirements that normally might be neglected in the cost estimate. Since labor may no longer be readily available on-site, such routine functions as facility inspection and supervision and review of work must be explicitly included.

3.6 The post-closure cost estimate covers the period beginning at the completion of closure of the facility and lasts for 30 years thereafter.

The post-closure cost estimate does not cover the cost of maintaining any partially closed portions of the facility during facility life. However, the fact that partial closure has occurred for portions of the facility does not in any way shorten the period of post-closure care required for the purposes of the post-closure cost estimates. The post-closure period begins with the professional engineer's certification of adequate closure. As a result, provision should be made for any normal remedial measures early in the post-closure period, such as significant portions of the vegetation failing to develop adequately.

3.7 Post-closure expenditures can be expected to occur in two categories: regular annual expenditures and expenditures that occur with less than annual frequency. The written estimate of the annual cost of post-closure monitoring and maintenance is equal to the sum of regular annual expenditures plus the expected number of non-annual expenditures times their costs.

This can be written as the following formula:

$$P = A + \sum \frac{F_i N_i}{30}$$

where P is the annual post-closure cost estimate, A is the size of expenditures occurring annually, F_i is the number of times over 30 years non-annual expenditure i is expected to occur, and N_i is the cost of non-annual expenditure i. There may, of course, be several kinds of annual expenditures and several kinds of non-annual expenditures. Specific types of non-annual expenditures that need to be considered include provisions for special activities resulting from unusual weather, replacement of equipment, and provisions for replanting and other similar activities in the two to five years following closure.

4.0 PREPARING AND DOCUMENTING THE CLOSURE AND POST-CLOSURE COST ESTIMATES

Although written closure and post-closure cost estimates are required, the regulation does not specify format or documentation suitable for this cost estimate. As a result, the ultimate requirements in this area will be up to the discretion of the Regional Administrator. Certain general guidance may, however, prove useful. The cost estimate must ultimately contain at least enough detail so that the Regional Office can make a reasonable evaluation of its validity at the time of inspections during interim status.

The overall goal of the cost estimate and its documentation is to provide an estimate of the costs and the documentation necessary to demonstrate the reasonableness of the estimate. It is not required that the cost estimate have the kind of detail and accuracy appropriate to a contractor preparing a bid for a job. There is little need for a highly polished cost estimate since these cost estimates are for a hypothetical task that is to take place in the rather distant future.

Four basic approaches which might be used in developing costs for the activities listed in the closure plan are:

- Costs based upon experience of the owner or operator
- Contractor estimates
- Cost estimation handbooks
- Workups from labor, material and equipment requirements

4.1 COSTS BASED UPON EXPERIENCE OF THE OWNER OR OPERATOR

The most directly relevant source of cost information, in many cases, will be the experience of the owner or operator in operating the facility. An example would be the costs of treating or disposing of inventory on-site, which will normally be a simple continuation of the normal operating practices of the business. In the simplest case, cost of treating or disposing of inventory may be computed as the annual operating costs divided by the fraction of a year required for adequately treating or disposing of inventory. Such an estimate could then be documented by the past year's accounts, the amount of material treated or disposed over that year, and evidence that the year had involved relatively typical activities (e.g., if, for a landfill, no trench had to be dug or covered over the course of the year, then the year might not be considered a suitable example from the viewpoint of assuming the most expensive closure conditions likely to occur over the life of the facility). Given that the requirement that a cost estimate be available on-site is either six or twelve months after notification of the cost estimation requirement, a variety of closure activities could be documented from noting the costs of the activity as they occur over the interim period.* For example, for a landfill, the costs and activities involved in partial closures could be documented and used as a base for unit cost estimates of the cost of final cover.

Similarly, costs of monitoring tests during post-closure will be similar to the costs of monitoring tests during facility life, though gathering samples will be more expensive due to the need to assume purchased labor and travel to the facility. Possibly the best source for costs and frequency of many kinds of post-closure non-routine expenditures is the actual experience in maintaining currently partially closed portions of a landfill.

4.2 CONTRACTOR ESTIMATES

A variety of costs, particularly if services are to be purchased from a contractor or contractors by the owner or operator, may be obtained from contractor estimates. For example, an owner or operator could ascertain the costs of certification by an independent professional engineer by asking several professional engineers for estimates of the costs of certifying the completion of activities listed in the closure plan. If an owner or operator plans to send either inventory or contaminated residues to an off-site TSDF, inquiries to ascertain distances, hauling costs, and treatment or disposal costs would be in order. It is not necessary for purposes of documenting, to have written and validated cost estimates. Adequate documentation could note who was contacted and their approximate estimates.

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*As discussed in Section 1.0, owners or operators of land disposal facilities are not required to have their cost estimates available until twelve months after the effective date of these regulations. Owners or operators of other facility types must have an estimate available within six months of the effective date of these regulations.

4.3 COST ESTIMATING HANDBOOKS

There are a variety of commercial engineering cost estimation manuals that provide guides to equipment and labor needs and unit costs of specific operations that may be relevant to various activities associated with closing hazardous waste facilities. Such manuals may be reasonably used as a source for cost estimates for closure costs. Care must be taken in using such manuals. They vary widely with respect to whether or not unit costs cited include such factors as administration, normal contingencies, profits, and whether or not allowances must be made to adjust theoretical work rates to normal field conditions.

From the owner's or operator's view, care should be taken that an overestimate is not produced by using estimates which allow for profits and capital recovery on equipment when this is not required if he is using his own equipment for closure. Distinct underestimates are possible if attention is not given to the indicated need for adjustment of theoretical work rates to normal field conditions and for administrative costs. As a result, suitable documentation for a cost estimate for an activity based upon such a handbook would be a copy of the relevant pages of the handbook, including those pages providing instructions as to the use of the unit cost estimates and any adjustments from the cited costs used in arriving at the unit cost estimate employed in the cost estimate itself.

4.4 WORKUPS FROM LABOR, MATERIAL AND EQUIPMENT REQUIREMENTS

In some cases, there may be no way to arrive at a useful cost estimate other than by a detailed workup of the costs. Such a workup would include an estimate of the labor, equipment, energy and material needs for the activity to be estimated, the basis for these assumptions, and the total time required for the activity. Allowance would then need to be made for supervision and administrative costs and any necessary adjustments for fully loaded labor and equipment costs.

5.0 ADEQUACY OF THE CLOSURE COST ESTIMATE

For the closure cost estimate to be judged adequate, it must meet the following criteria:

1. The closure cost estimate must contain cost estimates for all activities presented in the closure plan. The cost estimate must also reflect the quantities and methods associated with all of the activities presented in the closure plan. (Note that the adequacy of the cost estimate is therefore dependent on the adequacy of the closure plan.)

2. The closure cost estimate must be documented in order that the bases for the cost estimate can be checked.

3. The resulting cost estimate must reflect the actual costs of carrying out closure. This can be determined by a check of the sources listed for documentation providing that Rule 2 has been met. A cross-check can be made by using alternative sources, i.e., if the owner's or operator's cost estimate is based upon a contractor estimate, this may be checked through reference to a cost estimation manual, experience of other owners or operators, or inquiries to other contractors.

The cost estimate must be available upon the premises for inspection during interim status. As a result, it will be useful to have available simple and rapid checks as to the adequacy of the cost estimate. The remainder of this discussion is devoted, in part, to a discussion of simple checks that could be accomplished in less than an hour or two with the aid of the closure plan and a visit to the facility to determine the adequacy of the closure plan (see Section 12.0 of the draft guidance for Subpart G, Closure and Post-Closure Care). These checks are not intended for use by owners or operators and may not be used as a method for developing a cost estimate.

If an initial check raises questions as to the adequacy of the cost estimate, several steps may be taken. First, a copy of the complete cost estimate may be required and reviewed, and a check made of the documentation. It is quite possible that the cost estimate could be accurate and fall outside the ranges indicated in the discussion below. If, after review, the cost estimate still seems inadequate, the owner or operator could be specifically requested to make the desired alterations. If this approach fails to result in a satisfactory cost estimate, there are two possible recourses during interim status. The Regional Administrator could bring an enforcement case or he could request part B of the permit application and thus revise the cost estimate as part of the permit application process.

Unfortunately, the annual report of the facility, though it must include the cost estimate, does not contain adequate information to determine the accuracy of the cost estimate. In addition, the amount of inventory on-hand is not a required element of the permit application. Therefore, in order to check on the accuracy of the cost estimate, it may be necessary to visit the facility. An inspector could then obtain copies of the closure plan and cost estimate, and perform a quick review of the key variables for the closure plan, as discussed in Section 12.C of the draft guidance for Subpart G, Closure and Post-Closure Care.

Table 5-1 shows the key elements involved in verifying the closure cost estimate, listed by major types of activity involved. For each activity, the major elements required to check the adequacy are the activity indicator (the variable that determines the degree of the activity, e.g., quantity of inventory, volume of contaminated soil), unit costs (estimates of the unit costs for each activity of the facility in question), and sources for variation in unit costs from facility to facility. Also included in this table are current typical costs of each required activity. A relatively wide range is given due to variations depending upon the region and upon the nature of the wastes (e.g., high hazard wastes have greater costs than low hazard wastes). As these costs are national averages, more accurate estimates could be obtained

TABLE 5-1

CLOSURE COST ESTIMATE RAPID CHECKS

	ACTIVITY INDICATOR	UNIT COSTS	SOURCES OF VARIATION IN UNIT COSTS	TYPICAL 1980 COSTS*
Required of All Sites				
1. Inventory Disposal	Quantity of inventory Quantity of residues	On-Site: 30-80% of average off-site disposal costs Off-Site: 100% of average off-site disposal costs and hauling	Throughput, type of site, quality of disposal, nature of waste	Off-site disposal costs by type of facility: Incinerator - $100-200/ton Landfill - $ 80-150/ton Surface impoundment - $ 10- 30/ton Land treatment - $ 10- 40/ton Hauling costs - $ .02-$.10 per ton mile
2. Decontamination and Decommissioning	Volume of contaminated soil Volume of wastewater Amount of equipment and facilities	On-Site: 30-80% of average off-site disposal costs. Off-Site: 100% of average off-site disposal costs and hauling	Throughput, type of site, quality of disposal, nature of waste	Off-site disposal costs by type of facility: Incinerator - $100-200/ton Landfill - $ 80-150/ton Surface impoundment - $ 10- 30/ton Land treatment $ 10- 40/ton Hauling costs - $ .02-$.10 per ton mile
3. Monitoring	Number of tests	Average costs of tests	Regional, monitoring plan requirements	$200-500/well**
4. Certification	Man-hours of professional engineer time	$/hour of professional engineer time	Regional	$50-100/hour of professional engineer time
Required of Landfills and Some Surface Impoundments				
1. Cover				
a. Clay	Acres not covered, depth of cover		Terracing, nature of cover, design of cover, type of soil	$500-1,500 per foot per acre
b. Synthetic Liners	Acres not covered		Terracing, liner material, thickness of liner material	$500-20,000 per acre
2. Vegetation	Acres not vegetated, type of vegetation		Terracing, nature of cover, design of cover, type of soil, type and density of seed, provision for replanting	$400-1,500 per acre
Optional				
1. Leachate Collection, Removal and Treatment				
2. Gas Monitoring and Collection				
3. Additional closure requirements				

*In verifying the closure cost estimate, local updated costs are preferable. See Text.

**These costs are for ground-water monitoring analyses as specified in the regulations; air and soil monitoring are not included. The estimate is based on the most extensive monitoring that could be required within a six month closure period.

using average costs for the specific area. These costs also must be adjusted annually for inflation. A mechanism for making this inflation adjustment is discussed in Section 8.0.

For example, to check the adequacy of the cost estimate of treating or disposing of inventory, one would:

(1) Determine the adequacy of the estimated amount of inventory (this could most readily be done by examining the closure plan and facility conditions to determine whether the closure plan adequately reflects inventory needs of the facility);
(2) Determine whether, in the case of treatment facilities (including incinerators), provision has been made for treating, disposing, or removing residues off-site which result from treating inventory;
(3) Multiply the quantity of inventory in the closure plan by the unit costs given in the Table; and
(4) Consult the variability factors listed in the Table (e.g., throughput, type of facility, nature of waste, on- or off-site disposal), to determine whether the facility should be at the high or low end of the range for unit costs.

5.1 ACTIVITIES RELEVANT TO ALL FACILITIES

5.1.1 Treating, Disposing, or Removing Inventory

For facilities not engaged in disposal requiring post-closure care (all types of facilities except landfills, and surface impoundments and land treatment facilities in which hazardous wastes remain after closure), treating, disposing or removing inventory will frequently be the largest single cost element. The exceptions to this rule of thumb will normally be situations in which unusual decontamination problems occur, such as large amounts of waste water accumulating at the facility. The key unit parameters in determining the costs of treating, disposing or removing inventory to an off-site TSDF are the amount of inventory on-hand and, for incineration and processes involving treatment, the relationships between inventory processes and residues to be disposed of or treated on-site or removed to an off-site TSDF. The quantity of inventory on-hand will vary enormously depending on the type of facility, the annual throughput of the facility, and management practices. For some types of facilities, inventory can be minimal. For example, some landfills accept only trucked-in wastes on a space-available basis. For such a landfill, there would very seldom be any inventory at all. It is also possible, however, that start-up problems or, in the case of landfills, failure of a major cell or cells could lead to a situation in which there is an enormous amount of inventory which cannot be quickly worked off, and this would have to be accounted for in the cost estimate.

The unit costs of removing inventory are dependent upon whether the inventory is to be disposed of or treated on-site or removed to an off-site TSDF. In the vast majority of cases at disposal facilities, the disposing or treating of inventory will take place on-site. If disposal or treatment takes place on-site, the unit costs can be expected to fall between 30 and 80 percent of the prevalent Regional costs for removing the inventory to an off-site TSDF. On-site costs will be less than off-site costs because closure costs need only include the immediate operating costs of disposing or treating inventory and not factors for capital recovery, land, etc. The variation will depend upon the type of facility, its normal throughput (because of economies of scale, small facilities will have higher unit costs than large facilities for almost all types of facilities), the quality and safety of disposal practices at the facility, and the nature of the wastes. For a landfill which always maintains adequate open trench capacity, inventory disposal costs could be a very small fraction of normal off-site landfill disposal costs. This is because the costs of building the trench would not need to be included, and the costs of cover and vegetation are covered separately. Under these circumstances, costs for treating or disposing of inventory could be lower than the 30 percent indicated. For inventory or residue that must be removed to an off-site TSDF, unit costs will be 100 percent of normal off-site costs in the Region, plus appropriate hauling costs.

5.1.2 Decontaminating the Facility

Under certain circumstances, decontaminating the facility could be the largest cost element for the facility. This could be the case if large quantities of soil are contaminated, as might occur at any poorly run facility or at many improperly run surface impoundments, or if large amounts of waste water have accumulated at the facility. For many facilities, however, decontamination will be a relatively minor cost element requiring only general cleanup of equipment and facilities. The key activity indicators for decontaminating the facility are: quantity of contaminated soil; quantity of contaminated waste water; and amount of equipment and facilities requiring cleaning.

For contaminated soil and waste water, the relevant unit costs will be those cited for disposing or treating inventory, i.e., costs for disposing or treating the soil and water on-site or off-site. For equipment and facilities, the costs will depend upon cleaning costs themselves and whether or not the residues resulting from cleaning will require treatment as hazardous waste.

5.1.3 Monitoring

A facility must continue monitoring practices during the closure period; therefore, some costs must be included for monitoring. The costs may be estimated using the current lab costs for the tests in the Region and will vary regionally and according to the monitoring plan in place for the facility.

5.1.4 Professional Engineer Certification

The closure cost estimate must include provisions for the costs of certification by an independent professional engineer. Like monitoring, this will normally be a relatively minor cost element. The activity indicator for certification is the hours spent on-site by the professional engineer, which will normally depend upon the length of the closure period and the amount of activity which must take place. The unit cost parameter is dollars per hour of professional engineer time in the Region.

5.2 COSTS REQUIRED ONLY OF LANDFILLS AND SURFACE IMPOUNDMENTS

5.2.1 Cover

Some form of cover will usually be required for both landfills and surface impoundments which have hazardous wastes remaining after closure. Cover and the associated vegetation (see Section 5.2.2) will normally be the dominating element in determining the costs of closure for a landfill or surface impoundment.

The materials to be used will depend on the types of soil available on-site as well as the conditions of the facility. Since purchasing soil off-site is costly, it is likely that most owners or operators will use soil available on-site, if at all possible, for the final cover, i.e., the layer with low permeability and the layer capable of supporting vegetation, if applicable. It is possible to improve the quality of available soil by blending various soils, using soil additives, or making other provisions which would provide equivalent protection. For example, soil blending and synthetic additives may decrease the permeability of the on-site soil as well as make certain soils more capable of supporting vegetation. In addition to improving the quality of available soil, the Agency anticipates that many owners or operators will use membrane liners protected above and below by buffer soil layers instead of compacted clay for the layer of the cover with low permeability. These membrane liners may be cost effective if adequate on-site soil material is unavailable or an acceptable degree of compaction is not possible at a particular facility, given the wastes disposed or facility conditions.

When clay is used as a liner material, the key activity indicators are acres not yet covered and the depth of the cover. As noted in the closure plan, decisions as to the depth of the cover and the adequacy of on-site materials are dependent on engineering judgment and are not covered in this guidance document. The costs associated with such cover may vary from $500 to $1500 per foot per acre of cover. The key sources of variation are:

(1) The amount and nature of terracing to be used in the cover;
(2) The depth of the area to be filled in the case of surface impoundments;
(3) The nature of the cover, including whether or not treatment is required to achieve proper degrees of impermeability; and
(4) The design of the cover.

For synthetic liners, the key activity indicator is the acres not covered. The costs associated with such covers vary widely, depending on the type of material chosen and the thickness needed to ensure adequate low permeability. It is not the purpose of this document to assess alternative materials or to provide guidance as to the level of permeability which is acceptable. The costs associated with installed liner material per acre vary from $5,000 to $20,000 per acre. The key sources of variation are:

(1) The amount and nature of terracing to be used in the cover;
(2) Type of liner material chosen; and
(3) Thickness of material necessary to achieve desired degree of permeability.

5.2.2 Vegetation

For most facilities, some vegetation will be required in order to stabilize the cover and prevent erosion problems. The key activity indicators are the number of acres in need of vegetation (which may include areas previously seeded but for which vegetation has not properly developed) and the type of vegetation to be employed. Unit costs can be expected to range from $400 to $1,500 per acre. The lower end of the range would represent the costs of minimum fertilization and planting with no provision for reseeding and replanting of any kind. The maximum costs would represent the costs of providing a lawn-type cover. Other key variables in determining cost of vegetation are:

(1) The type of soil (including determining the degree of fertilizer required); and

(2) The type of seed used.

Establishing complete vegetation within the 90 days to six months over which closure will normally take place cannot be attained. As a result, some costs associated with developing and establishing vegetation will probably take place early in the post-closure period. Therefore, the adequacy of the closure plan with respect to vegetation should be checked in coordination with an examination of the provisions for maintaining vegetation in the early years of the post-closure plan.

5.2.3 Optional Measures

Three kinds of optional measures, bearing significant costs, may be necessary at some facilities: collection, removing and treating leachate; collecting gas; and additional measures required to protect human health and the environment. Even for facilities with leachate collection systems, the cost of leachate collection, removal, treatment and disposal for closure will normally be the relatively minor cost of occasionally collecting the leachate and hauling it away to an off-site TSDF. In certain rare cases, leachate build-up may be great enough to require an extensive on-site treatment and disposal system. If this is the case, this could be a significant cost during the closure period. Maintaining an existing gas collection system normally will be a relatively minor cost. At certain facilities, additional activities may be required to ensure the protection of human health or the environment, such as those discussed in Section 9.0 of the draft guidance for Subpart G. Such measures could be extremely expensive and would constitute a large share of closure costs; however, the exact combination of necessary measures will be extremely site-specific.

6.0 ADEQUACY OF THE POST-CLOSURE COST ESTIMATE

For the post-closure cost estimate to be judged adequate, it must meet the following criteria:

1. The post-closure cost estimate must contain cost estimates for all activities presented in the post-closure plan. The cost estimate must also reflect the quantities and methods associated with all of the activities presented in the post-closure plan. (Note that the adequacy of the cost estimate is therefore dependent on the adequacy of the post-closure plan.)

2. The post-closure cost estimate must be documented so that the bases for the cost estimate can be checked. Documentation may be performed in a variety of ways; however, it must be provided in such a way that the sources can be reviewed and judged by an outside party. For example, if an owner or operator states that a cost estimate was taken from an engineering cost estimation manual, the estimate could be easily verified.

3. The resulting cost estimate must reflect the actual costs of carrying out post-closure activities. This can be determined by a check of the sources listed for documentation providing that Rule 2 has been met. A cross-check can be made by using alternative sources, i.e., if the owner's or operator's cost estimate is based upon a contractor estimate, this may be checked through reference to a cost estimation manual, experience of other owners or operators, or inquiries to other contractors.

The cost estimate must be available on the premises for inspection during interim status. As a result, it will be useful to have available simple and rapid checks as to the adequacy of the cost estimate. The remainder of this section is devoted to a discussion of simple checks of the costs of specific activities that could be used with the aid of the closure plan and a visit to the facility to determine the adequacy of the post-closure plan (see Section 12.0 of the draft guidance for

Subpart G, Closure and Post-Closure Care). These checks are not intended for use by owners and operators and may not be used as a method for developing a cost estimate.

If an initial check raises questions as to the adequacy of the cost estimate, several steps may be taken. First, a copy of the complete cost estimate may be requested and reviewed, and a check made of the documentation. It is quite possible that the cost estimate could be accurate and fall outside the ranges indicated in the discussion below. If, after review, the cost estimate still seems inadequate, the owner or operator could be specifically requested to make the desired alterations. If this approach fails to result in a satisfactory cost estimate, there are two possible recourses during interim status. If the cost estimate is obviously completely inadequate, the Regional Administrator may start an enforcement action or he may request part B of the permit application and revise the cost estimate as part of the permit application process.

Unfortunately, the annual report of the facility, though it must include the cost estimate, does not contain adequate information to determine the accuracy of the cost estimate. Therefore, in order to check on the adequacy of the cost estimate, it may be necessary to visit the facility. An inspector could then obtain copies of the post-closure plan and cost estimate and conduct a quick review of the key variables for the post-closure plan, as discussed in Section 12.0 of the draft guidance for Subpart G, Closure and Post-Closure Care.

Table 6-1 shows the costs of certain activities which may be associated with post-closure cost estimates. This is a list of selected major activities, and is not intended to reflect all possible post-closure activities. These activities have been broken down by key cost elements rather than by elements of the post-closure plan. For example, one heading in Table 6-1 is "Inspections and Facility Visits." The table simply shows the expected costs of such visits per hour on-site. Determining the number of inspections and facility visits required will be highly site-specific and will depend upon the post-closure plan. Further, these inspections and facility visits may serve a variety of purposes in the post-closure plan. For example, inspections and facility visits may be for the purpose of ensuring adequate erosion control, maintaining surveyed benchmarks, obtaining ground-water monitoring samples, or checking the adequacy of leachate collection facilities.

Table 6-1, for each activity indicated, shows an estimate of unit costs and notes the sources of variation in these unit costs. The unit costs are given in 1980 dollars. In order to maintain the accuracy of Table 6-1, it should be updated on an annual basis to reflect inflation. A discussion of the methods for adjusting the cost estimates to account for inflation is provided in Section 8.0. The sources of variation in unit costs are specific to the headings listed. Two generic sources of variation, however, have not been noted. First, all costs can be expected to vary regionally and locally. Ideally, these national estimates of unit costs should be replaced by costs developed from experience for the region or state in which the facility is located. Second, all costs will vary with the remoteness of the facility. Since most post-closure activities are relatively small in scale and may involve only a few days on-site, significant travel time to and from the facility will have a noticeable effect on almost all costs.

6.1 INSPECTIONS AND FACILITY VISITS

As noted above, inspections and facility visits may be needed for a variety of purposes. The unit costs given will thus be relevant in checking the costs of a variety of activities. The estimated unit costs in 1980 dollars are $20 to $100 per hour on-site. The chief source of variation in these unit costs will be the professional level of the personnel involved. It will normally be useful to have an inspection or facility visit by a professional engineer at least once a year. Inspections and facility visits by less technically qualified personnel will depend upon the specifics of the post-closure plan, the climate, and the size and nature of the facility.

TABLE 6-1

COSTS OF SELECTED POST-CLOSURE ACTIVITIES

ACTIVITY	UNIT COSTS*	SOURCE OF VARIATION IN UNIT COSTS**
1. Inspection/Facility Visits	$20-100/hr. on-site	Professional level of personnel
2. Reestablishing Cover and Vegetation	$300-1500/acre	Amount of erosion Nature of cover Type of soil Amount & density of seed
3. Fertilizing	$50-200/acre	Amount of fertilizer Method of spreading
4. Mowing	$10-30/acre	
5. Ground-water Monitoring	$200-600/well	Monitoring plan requirements
6. Maintaining and Replacing Fences	$.20-.80/ft./yr.	Type of fence Climate
7. Collecting, Removing and Treating Leachate	$.20-.80/gallon	Chemical composition

*1980 dollars.

**All costs of all activities vary by region and with the remoteness of the facility.

6.2 REESTABLISHING COVER AND VEGETATION

Reestablishing cover and vegetation may be necessary for a variety of purposes, including:

- Replanting to establish vegetation not adequately established during closure;
- Replanting to repair minor erosion or rodent control problems;
- Reestablishing cover lost as a result of a major contingency, such as a major storm or flood; and
- Reestablishing cover to correct for subsidence problems.

The costs of this activity in 1980 dollars may range from $300 to $1,500 per acre. This cost will vary according to the nature of the cover, the type of soil used, and the amount and density of seed. In addition, the costs can be expected to vary according to the amount of erosion or subsidence which necessitates replacing the topsoil or cover material. The lowest costs are for simple replanting, and the highest are for reestablishing and compacting as well as reseeding substantial portions of the clay cover and topsoil.

6.3 FERTILIZING

Depending upon the vegetation, topsoil employed, and climate, some fertilization may be necessary. The frequency will be highly variable. The estimated range of costs for this activity is $50 to $200 per acre with the variation dependent upon the amount of fertilizer and the method of spreading it.

6.4 MOWING

Mowing is necessary in any climate in which deep rooted vegetation may readily be established. In most cases, it will be the most cost effective means of preventing such deep rooted vegetation. In some climates, mowing requirements may be minimal or there may be more cost effective methods than mowing for ensuring that deep rooted vegetation does not become established. The estimated range of costs in 1980 dollars is $10 to $30 per acre.

6.5 GROUND-WATER MONITORING

At all facilities, a ground-water monitoring program of some kind will be required. In addition to the costs of associated site visits to gather samples, these costs will be based on the average costs of the tests required, which are the result of the monitoring plan requirements.

6.6 MAINTAINING AND REPLACING FENCES

Many facilities will be required to have some kind of fence as security during the post-closure period. Assuming the use of some type of chain link fence, provision will need to be made for replacing the fence at least once over the 30-year post-closure period. In addition, some provision must be made for inspecting and maintaining the fence. It is estimated that the cost of such maintenance and replacement will be $.20 to $.80 per linear foot of fence per year. The variation is dependent upon the type of fence used and the severity of the climate.

6.7 COLLECTING, REMOVING, AND TREATING LEACHATE

At some facilities, a system for collecting, removing, and treating leachate may be required during post-closure. The estimate given here is based on the assumption that a small amount of leachate will be collected periodically and removed to an off-site TSDF. The costs of an extensive leachate collection system requiring treatment on-site would normally be much higher. The estimated range in costs is from $.20 to $.80 per gallon of leachate removed, with the range in the costs depending in part upon the chemical composition of the leachate.

7.0 REVISING THE CLOSURE AND POST-CLOSURE COST ESTIMATES

The closure and post-closure cost estimates must be revised whenever a change in the closure or post-closure plan is made that affects the costs of closure or post-closure care. Changes to closure and post-closure plans are discussed in Sections 11.1 and 11.2 of the guidance for Subpart G of the Interim Status standards. Changes in the closure plan which may cause a revision in the closure cost estimate include:

- Change in facility size and/or capacity;
- Changes in technology that may affect treatment and disposal or decontamination techniques, type of cover chosen, etc.;
- Changes in the closure schedule which alter the length of the closure period by greater than one month (e.g., severe weather conditions may halt construction activities and extend the closure period by more than one month);
- Changes in the schedule of periodic activities which affect activities required at closure (e.g., failure to partially close a facility would mean that a larger area than previously estimated would need to be closed at closure; the closure plan must always account for the maximum extent of the operation open at any time over the life of the facility);
- Changes in types and/or quantities of wastes that affect activities required at closure (e.g., the type and/or quantity of waste on-site at closure will affect the choices of treatment and disposal; for example, the amount of waste removed to an off-site TSDF by the owner or operator of an incinerator depends on the types and quantities of residuals that remain after burning the wastes. The types and quantities of waste can also affect monitoring requirements and cover requirements);

- Change in maximum quantity of inventory ever expected on-site;
- Change in cover requirements from what was originally proposed;
- Changes in ground-water monitoring requirements as a result of an owner's or operator's operating experience or new data which was not available when the plan was written. The ground-water monitoring regulations stipulate that all or part of the requirements may be waived if there is a low potential for pollution (§265.90). Revisions will also be likely when the EPA provides more guidance and technical engineering data on the kinds of monitoring appropriate for hazardous waste facilities; and
- Operating contingencies during closure which may affect closure requirements (e.g., inclement weather causes construction problems; more contaminated soil needs to be disposed at closure than anticipated as a result of problems occurring during operation).

Changes in the post-closure plan which may cause a revision in the post-closure cost estimate include:

- Change in facility size which will affect the extent of maintenance required;
- Changes in monitoring requirements as a result of an owner's or operator's operating experience, new data which was not available when the plan was written or modifications approved by the Regional Administrator (e.g., changes in the number of wells monitored and samples, the frequency of analyses, types of analyses required). During the 30-year post-closure period, the owner or operator may petition the Regional Administrator to discontinue or alter the monitoring requirements; alternatively, under certain circumstances,

the Regional Administrator may require an owner or operator to continue monitoring beyond 30 years. Revisions will also be likely when the EPA provides more guidance and technical engineering data on the kinds of monitoring appropriate during post-closure;

- Changes in annual routine maintenance, including changes in the nature and frequency of the activities required (e.g., a more extensive erosion control program may be required than originally anticipated);
- Changes in activities required on an intermittent basis or changes in the frequency of these activities (e.g., an accelerated replanting schedule or more frequent replacement of wells than anticipated);
- Operating contingencies which occur during the life of the facility or post-closure which affect post-closure activities (e.g., severe weather conditions affecting activities required for erosion control, cover maintenance, or maintenance of diversion structures);
- Changes in surrounding land use (e.g., if the population density increased, the measures needed to maintain facility security might change; ground-water monitoring program might be affected);
- Changes in monitoring and maintenance technology; and
- Modifications approved by the Regional Administrator; the owner or operator may petition the Regional Administrator to allow some or all of the requirements for post-closure to be discontinued or altered before the post-closure period is ended; any such changes can only be made after the post-closure period begins and would constitute a revision to the post-closure plan made during post-closure.

Revisions may be desirable that either raise or lower the closure and post-closure cost estimates. For example, the closure cost estimate may need to be revised and increased if partial closure schedules are not met or if there is unexpected accumulation of inventory due to temporary problems at the facility. It is quite possible, however, that the cost estimate may need to be revised downward. A facility may have very large inventory due to temporary start-up problems at the time the cost estimate is first developed which is later reduced to a more normal inventory. In such a situation, revising the closure cost estimate downward would be reasonable. It is also possible, given the rapid development in some types of hazardous waste disposal, that new technologies may offer much less expensive means of carrying out certain activities than are now envisioned. This would also be a legitimate cause for revisions of the plan and cost estimate.

8.0 ADJUSTING THE COST ESTIMATES TO ACCOUNT FOR INFLATION

Subpart H of the Interim Status Standards requires that both the closure and post-closure cost estimates be adjusted annually for inflation. This adjustment is to take place on the anniversary of the effective date of the regulations, November 19, 1980. Although owners or operators of land disposal facilities are not required to have estimates available until May 1981 (six months from the effective date of these regulations), all owners or operators are required to adjust their estimates beginning in November 1981 and annually thereafter. Adjustments of the post-closure cost estimate for inflation need not take place once the facility is closed.

Data for calculating the inflation adjustment factor must be obtained from the "...annual Implicit Price Deflator for Gross National Product as published by the U.S. Department of Commerce."* This price deflator is published in the Survey of Current Business, a U.S. Department of Commerce, Bureau of Economic Analysis, publication, and in Economic Indicators, a Council of Economic Advisors publication. These documents are published monthly and subscriptions may be obtained from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. This information also may be obtained by calling the Bureau of Economic Analysis, U.S. Department of Commerce.

The GNP price deflator was chosen as an appropriate inflation index and is more accurate than the more readily available Consumer Price Index and Wholesale Price Index. However, it is not as widely published as the other two indices. Thus, the typical hazardous waste facility owner or operator, in the normal course of his business, will not have data on the implicit price deflator for GNP or copies of the Survey of Current Business or Economic Indicators. Copies of these publications also may not be readily available in small libraries to which the owner or operator might have easy access. As a result, the EPA Regional personnel must have available the most recent editions of the Survey of Current Business or Economic Indicators and provide the necessary adjustment factor to owners or operators who telephone or write for this information.

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*EPA Interim Status Standards, 40 CFR §265.142(c).

Table 8-1 shows a sample of the section in the Survey of Current Business in which the GNP implicit price deflator may be found. The table is constructed to show how this section might appear on 19 November 1981, the "first anniversary of the effective date of the regulation." The numbers shown are hypothetical, as this guidance document is being written in May 1980. The implicit price deflator to be used is the first for which numbers appear, i.e., the one labeled Gross National Product as underlined in Table 8-1. The note "Index, 1972=100" may be ignored. The method of calculating the inflation adjustment factor required by the regulation makes the index year chosen and changes in the index year irrelevant. The regulation states:

> "The inflation factor must be calculated by dividing the latest published annual Deflator by the Deflator for the previous year."*

GNP deflators are normally developed both quarterly and annually. The regulation requires the use of the deflator listed in the column headed "annual totals." The quarterly data should be ignored entirely. The calculation of the inflation adjustment factor should use, for the latest published annual implicit price deflator, the deflator for 1980 (circled in the chart). The deflator for the previous year will then be

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*EPA Interim Status Standards, 40 CFR §265.142(c).

TABLE 8-1

HYPOTHETICAL SAMPLE PAGE OF SURVEY OF CURRENT BUSINESS

	1978	1979	1980	1978		1979				1980				1981		
	Annual Total			III	IV	I	II	III	IV	I	II	III	IV	I	II	III
GENERAL BUSINESS INDICATORS--Quarterly Series--Continued																
NATIONAL INCOME AND PRODUCT--Con.																
Quarterly Data Seasonally Adjusted																
Implicit price deflators:																
Gross National product......Index, 1972=100....	152.05	163.50	175.12	153.45	156.68	160.22	163.81	167.20	170.74	170.74	175.34	176.61	177.41	178.31	179.46	181.56
Personal consumption expenditures.......do....																
Durable goods............................do....																
Nondurable goods.........................do....																
Services.................................do....																
Gross private domestic investment:																
Fixed investment.........................do....																
Nonresidential...........................do....																
Residential..............................do....																
Govt. purchases of goods and services....do....																
Federal..................................do....																
State and local..........................do....																

the deflator for 1979 (also circled in the chart).* Using the example provided, the inflation adjustment factor is then calculated as the annual implicit GNP deflator for 1980 divided by the annual implicit GNP deflator for 1979, as follows:

$$\frac{175.13}{165.50}$$

resulting in an inflation adjustment factor of 1.058. This number is then multiplied by the last cost estimate to obtain the new current cost estimate. These numbers are hypothetical and do not represent actual 1981 data; they are presented solely to illustrate how to use the *Survey of Current Business* to make the necessary calculation.

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*The GNP implicit price deflator for a given year may be subject to revision. If the figure cited in a previous issue is different from the figure cited for the same quarter in the current issue, the owner or operator should use the current figure. If the owner or operator is requesting this information by telephone, he should ask for the GNP implicit price deflator for the previous year and for the year prior to the previous year.

9.0 SAMPLE COST ESTIMATES

9.1 INTRODUCTION

This section provides samples of cost estimates for closure of surface impoundments, land treatment facilities, landfills, incinerators, and a multiple process facility with tanks and small surface impoundments. A sample post-closure cost estimate for landfills is also provided. The purpose of these sample cost estimates is to illustrate the concepts involved in a proper cost estimate and suitable formats which might be employed. However, neither the cost estimates in total nor the unit costs are designed to be applicable to any specific facility. Neither the total costs nor the unit costs used in these cost estimates should be considered targets when the owner or operator prepares his own cost estimate.

The cost estimates are prepared in the form of a series of worksheets. This was considered the simplest mechanism for providing a careful, easily checked cost estimate. In the sample cost estimates given, each worksheet is accompanied by an explanation of each item on the worksheet. These explanations are designed to help indicate how the worksheet was developed. Explanations of this type would not be appropriate in the cost estimate prepared by the owner or operator. Instead, the owner or operator would include, for each item in the cost estimate, reference to the appropriate section of the closure or post-closure plan as applicable, and any necessary documentation as to the accuracy of specific unit costs.

9.2 EXAMPLE - SURFACE IMPOUNDMENTS

Sludge from an industrial wastewater treatment plant is pumped to a four-acre surface impoundment for stabilization. It is assumed that at the time of closure, the contents of the impoundment will measure a depth of 3 feet; this material will be 90 percent water and 10 percent solid sludges. The total depth of the impoundment will be 5 feet (allowing 2 feet of freeboard above the surface of the liquids). It is further assumed that all necessary equipment required to complete closure will have to be rented, as none is available on-site (the costs of equipment rental and manpower will be factored into the unit cost estimates for various operations). The costs of closure are developed for two options: 1) completely disposing of wastes on-site, and 2) removing all hazardous materials from the facility prior to closure.

SAMPLE CLOSURE COST ESTIMATING WORKSHEETS:
SURFACE IMPOUNDMENTS IN WHICH WASTES REMAIN AT CLOSURE

A. Removing Free Liquid and Decontaminating the Facility

In this case, it is assumed that free liquids can be removed by evaporation. Alternative possibilities that might be necessary and would result in somewhat different cost estimates are the transporting of free liquids to an off-site TSDF and the disposing of free liquids into surface waters after suitable treatment, either through a treatment facility already in place or a package treatment facility. For this example, all contaminated soil is disposed of in the impoundment; therefore, no additional costs are associated with decontaminating the soil.

1. Method used: As noted above, the method used for removing the free liquid is evaporation.

2. Time required to evaporate liquid: The calculations to justify this time would be taken from the closure plan. It is assumed that 70 days would be required for evaporation of free liquids.

3. Cost of routine operations per day: This includes the cost of inspecting the facility required once a week and any minor maintenance work that would need to be done as a result of these inspections.

4. Cost of maintenance during evaporation (Line 2 x Line 3): Cost of routine operations at $10 per day times 70 days results in a total cost of maintenance of $700.

5. Volume of remaining sludge: The volume of the remaining sludge is given as 1936 cu. yds. based on the initial assumption that the liquid in the pond is 10 percent sludge.

6. Source of sorbent materials: In this case, the sludge is to be solidified and buried on-site in the surface impoundment. As a result, sorbent materials are needed. It is assumed, for the example, that sorbent materials must be purchased off-site.

7. Cost of sorbent materials: Assume that sorbent materials (e.g., cement kiln dusts) are needed on a one-to-one ratio to the sludge and must be purchased with a delivered cost of $3.25 per cu. yd. The total cost is $6,292.

8. Unit cost of mixing and stabilization: The unit cost of mixing sorbent material with sludge is assumed to be $1.60 per cu. yd.

9. Cost of mixing and stabilization: This is calculated as 1936 cu. yds. of sludge plus 1936 cu. yds. of sorbent material, for a total of 3872 cu. yds. This is multiplied times $1.60 per cu. yd., to give a total cost of $6,195.

10. Total cost of removing free liquids and sludge stabilization (Line 4 + Line 7 + Line 9): The sum of the above costs is $13,187.

11. Decontaminate equipment: The assumed costs for decontaminating equipment is $500.

12. Decontaminate and flush any pumps or liquid lines: The assumed costs for decontaminating equipment is $2000.

13. Disposing or treating residues from decontamination: Assume that the costs for disposing or treating liquids and residues from the above decontamination processes is $1000.

14. Total costs of all activities on Worksheet A (Line 10 + Line 11 + Line 12 + Line 13): The sum of these activities is $16,687.

B. Placing Final Cap

1. Area to be capped: The area directly requiring a cap is 4 acres (19,360 sq. yds.) In addition, it is assumed that an additional acre of land area (4840 sq. yds.) surrounding the impoundment, containing dikes, etc., will require vegetation and, therefore, must undergo some preparation.

2. Required impermeable material: It is assumed that 25,813 cu. yds. of impermeable material will be required (19,360 sq. yds. x 4 ft. depth).

3. Source of impermeable material: It is assumed that suitable impermeable material can be obtained through bulldozing dikes and other appurtenances on-site.

4. Cost of material: Since the material is available on-site, there will be no cost.

5. Required topsoil: At the sample facility, it is assumed that 2 feet of the topsoil will be required in order to ensure adequate cover so that roots of the vegetation will not penetrate the cap. It is, therefore, assumed that 16,133 cu. yds. of topsoil (24,200 sq. yds. x 2/3 yd. depth) will be required.

6. Source of topsoil: In this case, it is assumed that topsoil is available on-site at a relatively short haul.

7. Cost of topsoil: Since the topsoil is available on-site, there will be no cost.

8. Cost per cubic yard for hauling, compacting and grading: It is assumed in this case that the unit cost of those services is $1.60.

9. Cost of placing impermeable portion of cap (Line 2 x Line 8): The result of these assumptions is that the cost of the cap in place (with suitable grading) is $41,301.

10. Cost of placing topsoil (Line 5 x Line 8): The cost of placing the topsoil, given the above assumptions, is $25,813.

11. Total cost of cap (Line 4 + Line 7 + Line 9 + Line 10): Summing the above elements, the total cost for the capping operation is $67,114.

C. Planting Final Vegetation

1. Area to be vegetated: The area to be vegetated is assumed to be 5 acres.

2. Type of vegetation to be used: The closure plan specifies that coarse field grass (a mixture of rye grasses and Kentucky fescue) will be employed for final vegetation.

3. Quantity of seed per acre: Based on discussions with facility operators, we assume that 150 pounds of seed will be used per acre.

4. Cost of seed per pound: Calls to local suppliers determined that seed is available at $.50 per pound.

5. Total cost of seed (Line 1 x Line 3 x Line 4): Given the above assumptions, the total cost of seed will be $375.

6. Type of fertilizer to be used: Given the topsoil and climatic conditions at the sample site, 10/10/10 fertilizer is assumed to be adequate.

7. Quantity of fertilizer per acre: Discussions with local suppliers indicated that .25 tons per acre would be a reasonable fertilizer application rate.

8. Cost of fertilizer per ton: Calls to local suppliers determined that fertilizer is available for $200 per ton.

9. Total cost of fertilizer (Line 1 x Line 7 x Line 8): Given the above assumptions, the total cost of fertilizer will be $250.

10. Cost of soil preparation per acre: Soil preparation, including both disking and fertilizing, is assumed to be $135 per acre (including equipment rental costs).

11. Total cost of preparing soil (Line 1 x Line 10): The total cost of preparing soil (excluding materials) is assumed to be $675.

12. Cost per acre for seeding: It is assumed that seeding the sample site will cost $200 per acre (including equipment rental costs).

13. Total cost of seeding (Line 1 x Line 12): The total cost of seeding (excluding materials) is assumed to be $1000.

14. Cost per acre of mulching: The cost per acre of purchasing and applying a hay mulch is assumed to be $140.

15. Total cost of mulching (Line 1 x Line 14): The total costs of mulching (including the costs of hay) are assumed to be $700.

16. Total costs for vegetation (sum of Lines 5, 9, 11, 13, and 15): Total costs for establishing vegetation are $2950.

D. Ground-water Monitoring

Assume that closure of the surface impoundment will require a total of 90 days. In order to determine the maximum possible ground-water monitoring costs, the most extensive monitoring needed at closure is assumed. Assuming that ground-water quality analyses are required annually and ground-water contamination analyses are required semi-annually, the most expensive case is that in which both sets of analyses are required during the 90-day closure period.

1. Number of wells monitored: For the sample surface impoundment, it is assumed that six wells would need to be monitored.

2. Number of samples per well: One sample is taken per well for both analyses.

3. Total number of samples (Line 1 x Line 2): Given the above assumptions, six samples are required.

4. Number of hours required for collecting the sample: It is assumed that experience has shown that two hours are sufficient to gather samples from each well.

5. Total number of hours required for collecting the samples (Line 3 x Line 4): For six samples, 12 hours would be required for collecting the samples.

6. Number of hours required for preparing and delivering the sample: It is assumed for the example that this can be done in two hours.

7. Person-hour costs for collecting samples: Assume that the fully-loaded costs for labor required for sample collection, preparation and delivery averages $15 per hour.

8. Total sample and collection costs ((Line 5 + Line 6) x Line 7): This results in total sampling and collection costs of $210.

9. Number of ground-water quality analyses: One analysis must be made for each well sample, for a total of six.

10. Number of ground-water contamination analyses: One analysis must be made for each well sample, for a total of six.

11. Unit cost of ground-water quality analysis: It is assumed that the cost of an analysis for the following parameters is $77 per sample:

Chloride - $6.00 per sample
Iron - $12.00 per sample
Manganese - $12.00 per sample
Phenols - $25.00 per sample
Sodium - $12.00 per sample
Sulfate - $10.00 per sample

12. Unit cost of ground-water contamination analyses: It is assumed that the cost of an analysis for the following parameters is $108 per sample:

pH - $4.00 per sample
Specific Conductance - $4.00 per sample
Total Organic Carbon - $25.00 per sample
Total Organic Halogen - $75.00 per sample

13. Total ground-water quality analysis costs (Line 9 x Line 11): For six samples at $77 per analysis, this yields a total cost of $462.

14. Total ground-water contamination analysis costs (Line 10 x Line 12): For six samples at $108 per analysis, this yields a total cost of $648.

15. Total analyses costs (Line 13 + Line 14): The total analyses costs, therefore, are $1,110.

16. Number of technical hours for administration: This includes all time necessary to administer and report the data from the analysis and is estimated as eight hours.

17. Person-hour technical costs: The fully-loaded cost required for this work is assumed to be $30 per hour.

18. Total technical costs for administration (Line 16 x Line 17): Given the above assumptions, total costs for administering the tests are assumed to be $240.

19. Number of clerical hours: Assume for this case that five hours of clerical time are required to produce the necessary reports.

20. Person-hour clerical costs: Assume the fully-loaded costs for clerical work are $8 per hour.

21. Total clerical costs (Line 19 x Line 20): Given the above assumptions, the total clerical costs are $40.

22. Total administrative costs (Line 18 + Line 21): The sum of technical and clerical costs are then $280.

23. Monitoring equipment maintenance: It is assumed that an average of $150 is required for a 90-day period to ensure adequate maintenance of monitoring equipment and wells.

24. Total monitoring costs (Sum of Lines 8, 15, 22, and 23): Total monitoring costs, excluding administration and contingencies, are then $1750.

E. Fence Maintenance

In this case, it is assumed that the area to be enclosed is 5 acres (24,200 sq. yd.). Assuming that the site is square, each side is 156 yards. The perimeter of the site is then 624 yards.

1. Length of fence to be replaced: Since this facility is to retain hazardous compounds, the integrity of its security fence is important. Our estimate is that 10% of the existing perimeter security fence will have to be replaced due to wear and corrosion.

2. Unit cost of replacing fence: The security fence is a galvanized 6-foot high chain link fence made of #9 wire. The installed unit cost of replacement sections is $13.06 per linear foot.

3. Total cost of replacing fence (Line 1 x Line 2): The cost of replacing the damaged fence sections is the product of the length of fencing needing replacement and the unit cost of replacing the fence, for a total of $2429.

F. Professional Certification

1. Number of person-hours required for inspections: It is assumed that 80 hours are required for periodically inspecting all aspects of closure of the surface impoundment.

2. Cost per person-hour: In this case, assume that a registered independent professional engineer may be hired at a cost of $75 per hour.

3. Total costs of independent professional engineer's time (Line 1 x Line 2): This yields a total cost of $6000 for the independent professional engineer.

4. Number of technical hours required for administrative duties: Assume that eight hours are required from the owner's or operator's staff for administrative duties connected with employing an independent professional engineer.

5. Person-hour costs for technical administrative duties: It is assumed that the total fully-loaded costs for the owner's or operator's staff are $30 per hour.

6. Total administrative costs for technical labor (Line 4 x Line 5): Given the above assumptions, the total administrative costs for technical labor are $240.

7. Number of clerical hours required for administrative duties: Assume that five hours of clerical time are required for the necessary typing and certification.

8. Person-hour costs for clerical administrative duties: Fully-loaded costs of clerical time are assumed to be $8.

9. Total administrative costs for clerical labor (Line 7 x Line 8): Given the above assumptions, total clerical costs are $40.

10. Total administrative costs (Line 6 + Line 9): Summing technical and clerical labor, the total administrative costs are $280.

11. Total certification costs (Line 3 + Line 10): The total costs for certification, including the engineer's fees and administrative costs, is then $6280.

G. Total Costs Including Administration and Contingencies

Items 1 through 6 give the costs of all activities on each of the preceding worksheets. Line 7 is the total of Lines 1 through 6, $97,210.

8. Administration: For administrative tasks, including taxes, insurance, and administration and supervision not included elsewhere, a total of 15 percent of total costs from Line 6 is used.

9. Contingencies: A general provision for contingencies of 15 percent of Line 6 has been included.

10. Total costs of closure (Line 7 + Line 8 + Line 9): The estimated total costs for closing the surface impoundment for the situation in which all wastes remain in the impoundment are estimated for the sample case to be $126,373.

SURFACE IMPOUNDMENTS
(All wastes remain in impoundment)
WORKSHEET A - REMOVING FREE LIQUID AND DECONTAMINATING THE FACILITY

1.	Method used	Evaporation
2.	Time required to evaporate liquid	70 days
3.	Cost of routine operations per day	$10
4.	Cost of maintenance during evaporation (Line 2 x Line 3)	$700
5.	Volume of remaining sludge	1936 cu. yds.
6.	Source of sorbent materials	Off-site
7.	Cost of sorbent materials ($3.25/cu. yd.; 1.1 ratio)	$6292
8.	Unit cost of mixing	$1.60/cu. yd.
9.	Cost of mixing and stabilization	$6195
10.	Total cost of removing free liquids and sludge stabilization (Line 4 + Line 7 + Line 9)	$13,187
11.	Decontaminating equipment	$500
12.	Decontaminating and flushing pumps and liquid liners	$2000
13.	Disposing or treating residues from decontamination	$1000
14.	Total costs of all activities (Line 10 + Line 11 + Line 12 + Line 13)	$16,687

SURFACE IMPOUNDMENTS
(All wastes remain in impoundment)

WORKSHEET B - FINAL CAP

1.	Area to be capped	19,360 sq. yds.
2.	Required impermeable material (including provision for suitable slope)	25,813 cu. yds.
3.	Source of material	On-site
4.	Cost of material	0
5.	Required topsoil	16,133 cu. yds.
6.	Source of topsoil	On-site
7.	Cost of topsoil	0
8.	Cost per cu. yd. of hauling, compacting, and grading impermeable material	$1.60
9.	Cost of impermeable portion of cap (Line 2 x Line 8)	$41,301
10.	Cost of placing topsoil (Line 5 x Line 8)	$25,813
11.	Total cost of cap (Line 4 + Line 7 + Line 9 + Line 10)	$67,114

SURFACE IMPOUNDMENTS

(All wastes remain in impoundment)

WORKSHEET C - PLANTING FINAL VEGETATION

1.	Area to be vegetated	5 acres
2.	Type of vegetation to be used	Coarse grass
3.	Quantity of seed per acre	150 lbs.
4.	Cost of seed per pound	$.50/lb.
5.	Total cost of seed (Line 1 x Line 3 x Line 4)	$375
6.	Type of fertilizer to be used	10/10/10
7.	Quantity of fertilizer per acre	.25 tons
8.	Cost of fertilizer per ton	$200/to
9.	Total cost of fertilizer (Line 1 x Line 7 x Line 8)	$250
10.	Cost of soil preparation per acre (excluding materials)	$135
11.	Total cost of preparing soil (Line 1 x Line 10)	$675
12.	Cost per acre of seeding (excluding materials)	$200
13.	Cost of seeding (Line 1 x Line 12)	$1000
14.	Cost per acre of mulching	$140
15.	Total mulching costs (Line 1 x Line 14)	$700
16.	Total costs for vegetation (Line 5 + Line 9 + Line 11 + Line 13 + Line 15)	$2950

SURFACE IMPOUNDMENTS

(All wastes remain in impoundment)

WORKSHEET D - GROUND-WATER MONITORING

1.	Number of wells monitored	6 wells
2.	Number of samples per well	1 sample
3.	Total number of samples (Line 1 x Line 2)	6 samples
4.	Number of hours required for collecting the sample (per sample)	2 hrs.
5.	Total number of hours required for collecting the samples (Line 3 x Line 4)	12 hrs.
6.	Number of hours required for preparing and delivering samples	2 hrs.
7.	Person-hour costs for collecting samples	$15
8.	Total sampling and collection costs ((Line 5 + Line 6) x Line 7)	$210
9.	Number of ground-water quality analyses	6 analyses
10.	Number of ground-water contamination analyses	6 analyses
11.	Unit cost of ground-water quality analysis	$77
12.	Unit cost of ground-water contamination analysis	$108
13.	Total ground-water quality analysis costs (Line 9 x Line 11)	$462
14.	Total ground-water contamination analysis costs (Line 10 x Line 12)	$648
15.	Total analyses costs (Line 13 + Line 14)	$1110
16.	Number of technical hours for administration (e.g., reporting data to EPA)	8 hrs.
17.	Person-hour technical costs	$30
18.	Total technical costs for administration (Line 16 x Line 17)	$240
19.	Number of clerical hours	5 hrs.
20.	Person-hour clerical costs	$8
21.	Total clerical costs (Line 19 x Line 20)	$40

WORKSHEET D (continued)

22.	Total administrative costs (Line 18 + Line 21)	$280
23.	Monitoring equipment maintenance	$150
24.	Total monitoring costs (Line 8 + Line 15 + Line 22 + Line 23)	$1750

SURFACE IMPOUNDMENTS

(All wastes remain in impoundment)

WORKSHEET E - FENCE MAINTENANCE

1.	Length of fence to be replaced	186 feet
2.	Unit cost of replacing fence	$13.06/linear ft.
3.	Total cost of replacing fence (Line 1 x Line 2)	$2429

SURFACE IMPOUNDMENTS
(All wastes remain in impoundment)
WORKSHEET F - PROFESSIONAL CERTIFICATION

1.	Number of person-hours required for inspections	80 hrs.
2.	Cost per person-hour	$75
3.	Total costs of independent professional engineer certification (Line 1 x Line 2)	$6000
4.	Number of technical hours required for administrative duties	8 hrs.
5.	Person-hour costs for technical administrative duties	$30
6.	Total administrative costs for technical labor (Line 4 x Line 5)	$240
7.	Number of clerical hours required for administrative duties	5 hrs.
8.	Person-hour costs for clerical administrative duties	$8
9.	Total administrative costs for clerical labor (Line 7 x Line 8)	$40
10.	Total administrative costs (Line 6 + Line 9)	$240
11.	Total certification costs (Line 3 + Line 10)	$6280

SURFACE IMPOUNDMENTS

(All wastes remain in impoundment)

WORKSHEET G - TOTAL COSTS INCLUDING ADMINISTRATION AND CONTINGENCIES

1.	Cost of removing free liquid and decontaminating the surface and ancillary facilities (From Worksheet A)	$ 16,687
2.	Cost of final cap (From Worksheet B)	$ 67,114
3.	Cost of planting final vegetation (From Worksheet C)	$ 2,950
4.	Cost of ground-water monitoring (From Worksheet D)	$ 1,750
5.	Cost of fence maintenance (From Worksheet E)	$ 2,429
6.	Cost of professional certification (From Worksheet F)	$ 6,280
7.	Total of Line 1 through Line 6	$ 97,210
8.	Administration	$ 14,581.50
9.	Contingencies	$ 14,581.50
10.	Total costs of closure (Line 7 + Line 8 + Line 9)	$126,373

SAMPLE CLOSURE COST ESTIMATING WORKSHEETS:

SURFACE IMPOUNDMENTS FROM WHICH WASTES ARE REMOVED AT CLOSURE

A. Removing All Free Liquids and Sludge

It is assumed in the sample case that free liquids will be removed through evaporation and that sludge will be placed in a tank truck and disposed off-site. A variety of other options are available. For removing free liquids, both transporting to an off-site TSDF and treating and discharging to surface waters are other options that could be used. For removing sludge, solidification could take place at the site, and the solidified sludge either disposed in an off-site landfill or in a landfill on-site, if there was one with interim status or a permit on-site.

1. Method used: As noted above, it is assumed in this case that evaporation is the method used to remove free liquids.

2. Time required to evaporate liquid: Based on calculations that would be shown in the closure plan, it is assumed for the sample case that 70 days would be required to evaporate liquid.

3. Cost of routine operations per day: This factor includes the required weekly inspection of the surface impoundment and a minimum allotment for necessary maintenance revealed by such inspections. This is estimated to be $10 per day.

4. Cost of maintenance during evaporation (Line 2 x Line 3): The total cost of maintenance of the surface impoundment is equal to 70 times $10 for a total of $700.

5. Estimated volume of sludge: Given the size of the surface impoundment and the assumption of 10 percent sludge, 1936 cu. yds. of sludge will remain after evaporation of free liquids.

6. Cost per cu. yd. of removing sludge off-site: It is assumed that off-site removal of sludges can be obtained for $40 per cu. yd. This cost takes into account the fact that the off-site TSDF facility will have to mix and stabilize the sludges, and assumes that they will, therefore, charge a premium for this service.

7. Removal costs per cu. yd.: It is assumed for the sample facility that removal costs are $1.60 per cu. yd. (including equipment rental).

8. Hauling costs per cu. yd.: It is assumed that the nearest landfill is 20 miles away. Unit costs of trucking the sludge from the impoundment to the landfill is assumed to be $3/cu. yd., based on discussions with trucking industry personnel.

9. Total costs (per cu. yd.) of disposal (Line 6 + Line 7 + Line 8): Total costs of off-site disposal are $44.60 per cu. yd.

10. Cost of removing sludge (Line 5 x Line 9): Given these assumptions, the cost of removing sludge is $86,346.

11. Total costs (Line 4 + Line 10): Total costs for removing free liquids and sludges is $87,046.

B. Decontaminating the Facility

1. Surface area of contaminated soil: It is assumed that 19,360 sq. yds. (the entire surface area of the surface impoundment) has contaminated soil.

2. Depth of removal: It is assumed in the sample case that this soil must be removed to a depth of 1 foot to ensure that no soil contaminated with hazardous waste remains in the surface impoundment.

3. Total volume to be removed (Line 1 x Line 2): The resulting total volume to be removed is 6453 cu. yds.

4. Cost of removal per cu. yd.: The assumed cost of removing soil is $1.60 per cu. yd. (including costs of renting equipment).

5. Total cost of removal (Line 3 x Line 4): The resulting costs for the sample case of removing the contaminated soil are $10,325.

6. Cost of hauling to off-site landfill per cu. yd.: The assumed hauling costs to an off-site landfill for final disposal of the contaminated soil are $3 per cu. yd.

7. Total cost of hauling (Line 3 x Line 6): The resulting total costs of hauling are $19,359.

8. Fee per cu. yd. for disposal in off-site landfill: It is assumed that the charge per cu. yd. for off-site disposal at the chosen landfill has been determined to be $30 per cu. yd.

9. Total cost of disposal (Line 3 x Line 8): The total costs for disposal, excluding hauling and soil removal, are then $193,590.

10. Decontaminating equipment: It is assumed that equipment can be decontaminated for $500.

11. Decontaminating and flushing pump and liquid lines: Assume that this can be done at the sample facility for $2000.

12. Disposing or treating residues from decontamination: It is assumed that residues resulting from the above decontamination steps must be disposed of at a cost of $1000.

13. Total costs (sum of Lines 5, 7, 9, 10, 11, and 12): The total costs for decontaminating the surface and ancillary facilities are $226,744.

C. Ground-water Monitoring

Assume that closure of the surface impoundment will require a total of 90 days. In order to determine the maximum possible ground-water monitoring costs, the most extensive monitoring needed during closure is assumed. Assuming that ground-water quality analyses are required annually and ground-water contamination analyses are required semi-annually, the most expensive case is that in which both sets of analyses are required during the 90-day closure period.

1. Number of wells monitored: For the sample surface impoundment, it is assumed that six wells would need to be monitored.

2. Number of samples per well: One sample is taken per well for both analyses.

3. Total number of samples (Line 1 x Line 2): Given the above assumptions, six samples are required.

4. Number of hours required for collecting the sample: It is assumed that experience has shown that two hours are sufficient to gather samples from each well.

5. Total number of hours required for collecting the samples: (Line 3 x Line 4): For six samples, 12 hours would be required for collecting the samples.

6. Number of hours required for preparing and delivering the samples: It is assumed for the example that experience has shown that this can be done in two hours.

5. Person-hour costs for technical administrative duties: It is assumed that the total fully loaded costs for the owner's or operator's staff are $30 per hour.

6. Total administrative costs for technical labor (Line 4 x Line 5): Given the above assumptions, the total administrative costs for technical labor are $240.

7. Number of clerical hours required for administrative duties: Assume that five hours of clerical time are required for the necessary typing and certifications.

8. Person-hour costs for clerical administrative duties: Fully-loaded costs of clerical time are assumed to be $8.

9. Total administrative costs for clerical labor (Line 7 x Line 8): Given the above assumptions, total clerical costs are $40.

10. Total administrative costs (Line 6 + Line 9): Summing technical and clerical labor, the total administrative costs are $280.

11. Total certification costs (Line 3 + Line 10): The total costs for certification, including the engineer's fees and administrative costs, is then $4780.

E. Total Costs of Closure Including Administration and Contingencies

Items 1 through 4 summarize the costs of the activities on each of the previous worksheets.

5. Total of Lines 1 through 4: The total costs for the activities listed in Lines 1 through 4 are $320,350.

6. Administration: The costs for administration, which includes insurance, taxes, and supervision and administration not included elsewhere, are assumed to be 15 percent of Line 5.

7. Contingencies: A provision for contingencies of 15 percent of Line 5 has been included.

8. Total costs of closure (Line 5 + Line 6 + Line 7): The total costs of closure including administration and contingencies for the sample surface impoundment, in the case where all wastes are removed from the impoundment, are $416,455.

7. Person-hour costs for collecting samples: Assume that the fully-loaded costs for labor required for collecting, preparing and delivering the samples averages $15 per hour.

8. Total sample and collection costs ((Line 5 + Line 6) x Line 7): This results in total sampling and collection costs of $210.

9. Number of ground-water quality analyses: One analysis must be made for each well sample, for a total of six.

10. Number of ground-water contamination analyses: One analysis must be made for each well sample, for a total of six.

11. Unit cost of ground-water quality analyses: It is assumed that the cost of an analysis for the following parameters is $77 per sample.

Chloride - $6.00 per sample
Iron - $12.00 per sample
Manganese - $12.00 per sample
Phenols - $25.00 per sample
Sodium - $12.00 per sample
Sulfate - $10.00 per sample

12. Unit cost of ground-water contamination analysis: It is assumed the cost of an analysis for the following parameters is $108 per sample.

pH - $4.00 per sample
Specific Conductance - $4.00 per sample
Total Organic Carbon - $25 per sample
Total Organic Halogen - $75.00 per sample

13. Total ground-water quality analysis costs (Line 9 x Line 11): For six samples at $77 per analysis, this yields a total cost of $462.

14. Total ground-water contamination analysis costs (Line 10 x Line 12): For six samples at $108 per analysis, this yields a total cost of $648.

15. Total analyses costs (Line 13 + Line 14): The total analyses costs, therefore, are $1110.

16. Number of technical hours for administration: This includes all time necessary to administer and report the data from the analysis and is estimated as eight hours.

17. Person-hour technical costs: The fully-loaded cost required for this work is assumed to be $30 per hour.

18. Total technical costs for administration (Line 16 x Line 17): Given the above assumptions, total costs for administering the tests are assumed to be $240.

19. Number of clerical hours: Assume for this case that five hours of clerical time are required to produce the necessary reports.

20. Person-hour clerical costs: Assume the fully-loaded costs for clerical work are $8 per hour.

21. Total clerical costs (Line 19 x Line 20): Given the above assumptions, the total clerical costs are $40.

22. Total administrative costs (Line 18 + Line 21): The sum of technical and clerical costs are then $280.

23. Monitoring equipment maintenance: It is assumed that an average of $150 is required for a 90-day period to ensure adequate maintenance of monitoring equipment and wells.

24. Total monitoring costs (sum of Lines 8, 15, 22, and 23): Total monitoring costs, excluding administration and contingencies, are then $1750.

D. Professional Certification

1. Number of person-hours required for inspections: It is assumed that 60 hours are required for periodic inspections of all aspects of closing the surface impoundment.

2. Cost per person-hour: In this case, assume that a registered independent professional engineer may be hired at a cost of $75 per hour.

3. Total costs of independent professional engineer's time (Line 1 x Line 2): This yields a total cost of $4500 for the independent professional engineer.

4. Number of technical hours required for administrative duties: Assume that eight hours are required from the owner's or operator's staff for administrative duties connected with employing an independent professional engineer.

SURFACE IMPOUNDMENTS

(All wastes removed from impoundment)

WORKSHEET A - REMOVING ALL FREE LIQUIDS AND SLUDGE

1.	Method used	Evaporation
2.	Time required to evaporate liquid	70 days
3.	Cost of routine operations per day	$10
4.	Cost of maintenance during evaporation (Line 2 x Line 3)	$700
5.	Estimated volume of sludge	1936 cu. yds.
6.	Cost of removing sludge off-site per cu. yd.	$40
7.	Removal costs per cu. yd.	$1.60
8.	Hauling costs per cu. yd.	$3.00
9.	Total costs per cu. yd. of disposal (Line 6 + Line 7 + Line 8)	$44.60
10.	Costs of removing sludge (Line 5 x Line 9)	$86,346
11.	Total costs (Line 4 + Line 10)	$87,046

SURFACE IMPOUNDMENTS

(All wastes removed from impoundment)

WORKSHEET B - DECONTAMINATING SURFACE AND ANCILLARY FACILITIES

1.	Surface area of contaminated soil	19,360 sq. yds.
2.	Depth of removal	1 ft.
3.	Total volume to be removed (Line 1 x Line 2)	6453 cu. yds.
4.	Cost of removal per cu. yd.	$1.60
5.	Total cost of removal (Line 3 x Line 4)	$10,325
6.	Cost of hauling to off-site landfill per cu. yd.	$3
7.	Total cost of hauling (Line 3 x Line 6)	$19,359
8.	Fee per cu. yd. for disposing in off-site landfill	$30
9.	Total cost of disposal (Line 3 x Line 8)	$193,590
10.	Decontaminating equipment	$500
11.	Decontaminating and flushing pump and liquid lines	$2000
12.	Disposing of residues from decontamination	$1000
13.	Total costs (sum of Lines 5, 7, 9, 10, 11, and 12)	$226,774

SURFACE IMPOUNDMENTS

(All wastes removed from impoundment)

WORKSHEET C - GROUND-WATER MONITORING

1.	Number of wells monitored	6 wells
2.	Number of samples per well	1 sample
3.	Total number of samples (Line 1 x Line 2)	6 samples
4.	Number of hours required for collecting the sample (per sample)	2 hrs.
5.	Total number of hours required to collect the samples (Line 3 x Line 4)	12 hrs.
6.	Number of hours required for preparing and delivering samples	2 hrs.
7.	Person-hour costs for collecting samples	$15
8.	Total sampling and collection costs ((Line 5 + Line 6) x Line 7)	$210
9.	Number of ground-water quality analyses	6 analyses
10.	Number of ground-water contamination analyses	6 analyses
11.	Unit cost of ground-water quality analysis	$77
12.	Unit cost of ground-water contamination analysis	$108
13.	Total ground-water quality analysis costs (Line 9 x Line 11)	$462
14.	Total ground-water contamination analysis costs (Line 10 x Line 12)	$648
15.	Total analyses costs (Line 13 + Line 14)	$1110
16.	Number of technical hours for administration (e.g., reporting data to EPA)	8 hrs.
17.	Person-hour technical costs	$30
18.	Total technical costs for administration (Line 16 x Line 17)	$240
19.	Number of clerical hours	5 hours
20.	Person-hour clerical costs	$8
21.	Total clerical costs (Line 19 x Line 20)	$40
22.	Total administrative costs (Line 18 + Line 21)	$280

23.	Monitoring equipment maintenance	$150
24.	Total monitoring costs (Line 8 + Line 15 + Line 22 + Line 23)	$1750

SURFACE IMPOUNDMENTS
(All wastes removed from impoundment)
WORKSHEET D - PROFESSIONAL CERTIFICATION

1.	Number of person-hours required for inspections	60 hrs.
2.	Cost per person-hour	$75
3.	Total costs of independent professional engineer certification (Line 1 x Line 2)	$4500
4.	Number of technical hours required for administrative duties	8 hrs.
5.	Person-hour costs for technical administrative duties	$30
6.	Total administrative costs for technical labor (Line 4 x Line 5)	$240
7.	Number of clerical hours required for administrative duties	5 hrs.
8.	Person-hour costs for clerical administrative duties	$8
9.	Total administrative costs for clerical labor (Line 7 x Line 8)	$40
10.	Total administrative costs (Line 6 + Line 9)	$280
11.	Total certification costs (Line 3 + Line 10)	$4780

SURFACE IMPOUNDMENTS

(All wastes removed from impoundment)

WORKSHEET E - TOTAL COSTS OF CLOSURE INCLUDING ADMINISTRATION AND CONTINGENCIES

1.	Cost of removing free liquids and sludge (From Worksheet A)	$ 87,046
2.	Cost of decontaminating facility (From Worksheet B)	$226,774
3.	Cost of ground-water monitoring (From Worksheet C)	$ 1,750
4.	Cost of professional certification (From Worksheet D)	$ 4,780
5.	Total of Line 1 through Line 4	$320,350
6.	Administration	$ 48,052.50
7.	Contingencies	$ 48,052.50
8.	Total costs of closure (Line 5 + Line 6 + Line 7)	$416,455

9.3 EXAMPLE - LAND TREATMENT FACILITIES

The following cost estimates were developed for a land treatment facility consisting of 50 acres of active fields for the processing of biodegradable hazardous waste. In addition to the disposal fields, the land treatment facility is equipped with a surface impoundment for waste storage and a separate surface impoundment for collecting run-off water.

The land treatment facility is designed to receive organic industrial sludge of high liquids content. This waste is applied to the land treatment fields at an application rate of 100 wet tons/acre (solids application rate ~5 tons/acre).

Waste received by the facility is stored in a lined surface impoundment. The surface impoundment is 5 feet deep (3 feet of waste and 2 feet of freeboard) and has a surface area of 1.23 acres. This corresponds to a waste holding capacity of 160,700 cubic feet. A pump system is available for transferring this liquid waste to the tank trucks.

The waste from the waste storage surface impoundment is spread on the fields using tank trucks. During the first 90 days of the planned closure period, all of the waste inventory will be disposed on the fields. This disposal will require one application to the field. Later in the closure period, run-off water from the separate run-off water surface impoundment will be disposed of in the same manner. This run-off water will have a very low concentration of hazardous wastes. Disking of the fields will be conducted shortly after each spreading to mix the waste with the soil and a second disking will be done two to three weeks after each spreading. Periodic disking will continue on a bimonthly basis thereafter.

During this prolonged closure period, the surface impoundments will be closed as well. Each of the two surface impoundments has its own closure plan as shown elsewhere in this guidance document. Therefore, the costs of decommissioning the surface impoundments are not computed in this example.

SAMPLES CLOSURE COST ESTIMATING WORKSHEETS:
LAND TREATMENT FACILITIES

A. Disposing of Waste Inventory

1. Maximum inventory to be disposed: For this case, the waste storage surface impoundment is filled to its maximum capacity of 5000 tons of low solids waste (or 1,198,878 gallons with a waste density similar to water).

2. Amount of run-off water to be disposed: a similar amount of somewhat contaminated water is expected to be disposed of from the surface water run-off impoundment. This mildly contaminated water is to be disposed of in the same manner as the inventory.

3. Total material to be disposed (Line 1 + Line 2): All of these impounded liquids (waste and run-off) are to be disposed of on-site by spreading on the land treatment facility fields.

4. Application rate: The waste is to be applied to the field by means of tank trucks equipped with spray bars. The application rate of 100 tons/acre corresponds to a solids application rate of 5 tons/acre. This application rate has been found to be acceptable based on the operating experience of the facility.

5. Acreage utilized: All 50 acres of the land treatment facility are in active operation and will be available for the disposal of the waste inventory and run-off. This is the lowest cost option for disposing inventory available to this facility.

6. Number of applications in the closure period: Two applications are planned. One application is the liquid waste inventory which will be completed within the first 90 days of the closure period as required by the interim status regulations. Subsequently, an application of the captured run-off water is planned.

7. Unit cost of spreading: The unit cost of spreading the liquids on the land treatment fields is $0.48 per ton or $48 per acre at the application rate of 100 tons per acre.

8. Total cost of spreading (Line 5 x Line 6 x Line 7): The total cost of spreading the waste inventory and the captured run-off water is the product of the acreage treated, the number of applications and the unit per acre cost of spreading.

9. Number of diskings required: A total of ten diskings will be required throughout the closure period. Four of the diskings will be carried out in the first part of the closure period (immediately after each of the two applications and several weeks after each application). Six additional diskings will be conducted throughout the rest of the closure period.

10. Unit cost of disking: The unit cost for disking the land treatment fields is the sum of tractor and implement costs and equipment operator labor costs. The equipment cost for disking is $.79 per acre. The cost is for both the tractor and the tandem disk. It includes insurance, taxes, repairs, fuel and lubrication but it does not include interest and depreciation. The labor cost (fully-loaded) is $20 per hour. The disking is accomplished at the rate of .167 hours per acre. In addition, extra labor time is required for related handling and care of the equipment. Thus, the actual labor time per acre is 1.2 times the implement time, yielding a labor rate of $4.01 per acre.

11. Total cost of disking (Line 5 x Line 9 x Line 10): The cost of disking the land treatment fields is the product of the acreage utilized, the number of diskings required during closure and the unit cost of disking.

12. Total costs for disposing of inventory (Line 8 + Line 11): The total cost for disposing of the waste inventory and run-off water is the sum of the total spreading costs and the total disking costs. After completing the land treatment, the hazardous waste will be completely decomposed.

B. Decontaminating the Land Treatment Facility

1. Area of facility contaminated: It should be noted that the 1200 sq. yds. of contaminated soil does not include any of the land treatment fields where controlled decomposition is occurring.

2. Depth of material removed: The contaminated soil is removed to a depth of 1 foot (.33 yds.). The soil at this land treatment facility is relatively impermeable. This makes a depth of 1 foot realistic for the excavation for the contaminated soil (since the mobility of the hazardous waste is restricted). The soil density is 90 lbs./cu. ft.

3. Unit cost for removal: The contaminated soil is removed and loaded into spreaders using rented earth-moving equipment. This excavation and loading operation is estimated to cost $1.60 per cu. yd. of contaminated soil.

4. Cost of removing contaminated soil (Line 1 x Line 2 x Line 3): The cost of excavating, removing and loading the contaminated soil is the product of the volume of the soil handled and the unit cost of the operation.

5. Quantity disposed on-site: All of the contaminated soil is to be disposed on the land treatment fields (on-site). The contamination in the disposed soil will decompose under supervised conditions. This contaminated soil will be spread after the waste inventory has been disposed. The contaminated soil will be spread on the fields at least several weeks after the last of the waste inventory is spread.

6. Quantity disposed off-site: No contaminated soil is to be disposed off-site due to the much higher cost of off-site disposal and the availability of the land treatment fields.

7. Application rate: An application rate of 10 tons of contaminated soil per acre is used. This solids application rate is acceptable because the waste concentration in the soil is quite low.

8. Acreage utilized: The contaminated soil is spread on the entire 50 acres of the land treatment facility.

9. Number of applications: Only one application is required to dispose of the entire volume of contaminated soil.

10. Unit cost of spreading: The unit cost for the spreading of the contaminated soil is the sum of tractor and implement costs and equipment operator labor costs. The equipment cost for spreading the waste is $.95 per acre. This cost is for both the tractor and the spreader. It includes insurance, taxes, repairs, fuel and lubrication but it does not include interest and depreciation. The labor cost (fully-loaded) is $20 per hour. The spreading of the waste is accomplished at the rate of .211 hours per acre. In addition, extra labor time is required for related handling and care of the equipment. Thus, the actual labor time per acre is 1.2 times the implement time, yielding a labor rate of $5.06 per acre.

11. Total cost of spreading (Line 8 x Line 9 x Line 10): The cost of spreading the soil is the product of the acreage and the unit cost per acre.

12. Number of diskings: The spread soil is disked to mix it with the soil of the land treatment fields. This one disking is conducted shortly after the contaminated soil is spread on the fields.

13. Unit cost of disking: The unit cost for disking is $4.08/acre. This cost includes equipment costs of $.79 per acre for the tractor and the tandem disk. This cost includes insurance, taxes, repairs, fuel and lubrication; but it does not include interest and depreciation. Labor cost is included at a cost of $20 per hour.

14. Total cost of disking (Line 8 x Line 12 x Line 13): The total cost for this disking is the product of the acres disked and the unit cost per acre.

15. Total cost of disposing of contaminated soil (Line 4 + Line 11 + Line 14): The total cost of disposing of the contaminated soil is the sum of the cost of removing the soil, spreading the soil, and disking the spread soil.

16. Cost of decontaminating equipment: At the end of the closure period, the equipment used on-site will be decontaminated by washing with detergents. The run-off cleaning water will be collected for disposal. A cost of $1000 is estimated for this task.

17. Disposing or treating of residues from equipment decontamination: The wastewater from the washing and other cleaning residues will be disposed off-site at a cost of approximately $1000. Off-site disposal of this residue is required because the land treatment facility is ceasing operation.

18. Total cost of decontaminating the facility Line 15 + Line 16 + Line 17): The total cost of decontaminating the land treatment facility is the sum of the costs of soil disposal, equipment decontamination, and decontamination residue disposal.

C. Monitoring Activities (Ground-Water and Soil)

Ground-Water Monitoring

It is assumed that closure of the land treatment facility will require a total of 15 months. In order to determine the maximum possible ground-water monitoring costs, the most extensive monitoring needed during closure is assumed. Assuming that ground-water quality analyses are required annually and ground-water contamination analyses are required semi-annually, the most expensive case is that in which two ground-water quality analyses and three ground-water contamination analyses are required during the 15-month closure period.

1. Number of wells monitored: Eight sampling wells are operated to monitor the composition of the ground-water at the land treatment site. Seven of the wells are downgradient from the land treatment fields and one well is upgradient.

2. Number of samples taken: Three "cycles" of ground-water sampling will be conducted during the 15-month long closure period. Two ground-water quality analyses and three ground-water contamination analyses are to be carried out. One sample may be used for both the ground-water quality and the ground-water contamination analysis. Therefore, during the closure period, a total of three samples are taken from each well.

3. Total number of samples (Line 1 x Line 2): The total number of ground-water samples taken during the closure period is the product of the number of monitoring wells and the number of samples taken from each well.

4. Number of hours for collecting the sample (per sample): Taking ground-water samples is a rather time-consuming practice. The well is pumped dry and allowed to refill. Then a sample is taken. The land treatment facility experience is that approximately two hours are required for each ground-water sample (including some time for moving about the fields).

5. Total number of hours for collecting the samples (Line 3 x Line 4): During the extent of the closure period, 24 samples will have to be collected, requiring 48 hours of labor.

6. Number of hours for preparing and delivering the sample: The ground-water samples must also be prepared and delivered to the laboratory for analysis. This work requires about three hours for a set of eight samples (one from each monitoring well).

7. Total number of hours for preparing and delivering the sample (Line 2 x Line 6): The total number of ground-water sample preparation and delivery hours in the closure period is the product of the number of sets of samples (cycles) and the unit operation requirement of three hours labor.

8. Person-hour costs for collecting and handling samples: The person-hour fully-loaded labor rate for taking and handling the ground-water sample is $15 per hour. This is the same labor rate as during the operating period of the land treatment facility.

9. Total ground-water sampling and collection costs ((Line 5 + Line 7) x Line 8): The total cost of ground-water sampling is computed by multiplying the hours required by the labor rate of $15 per hour.

10. Number of ground-water quality analyses: Sixteen ground-water quality analyses are required during the closure period. Two analyses are required for each well.

11. Number of ground-water contamination analyses: Twenty-four ground-water contamination analyses are required during the closure period. Three analyses are required for each well.

12. Unit cost of ground-water quality analysis. It is assumed that the cost of an analysis for the following parameters is $77 per analysis.

Chloride	$ 6/sample
Iron	$12/sample
Manganese	$12/sample
Phenols	$25/sample
Sodium	$12/sample
Sulfate	$10/sample

13. Unit cost of ground-water contamination analysis: It is assumed that the cost of an analysis for the following parameters is $108 per analysis:

pH	$ 4/sample
Specific Conductance	$ 4/sample
Total Organic Carbon	$25/sample
Total Organic Halogen	$75/sample

14-16. Total ground-water chemical analyses costs: The unit costs per analysis are multiplied by the number of analyses to yield the costs for each type of analysis. These two costs are added together to compute the total analyses costs.

Soil Monitoring

17. Number of soil core samples: Soil core samples are taken throughout the closure period. Four samples are taken in each quarter of the first year. In the fifth quarter of the closure period, 50 core samples are taken (one from each acre of the land treatment facility). This last set of 50 samples confirms that the waste has decomposed during the closure period. Thus, a total of 66 soil core samples are taken in the closure period (15 months in duration). Most of these samples are taken below the zone of waste incorporation to monitor any waste movement towards the water table. A few of the samples are taken from the zone of incorporation as well to monitor the decomposition of the waste material.

18. Labor hours required for each core sample: The taking of a soil core sample is a relatively simple process. Most of the time allocated to taking each sample is movement between the sample-taking locations.

19. Labor unit cost for collecting core samples: The unit cost of the labor for soil core sampling is $15 per hour fully-loaded.

20. Total cost of collecting the soil samples (Line 17 x Line 18 x Line 19): The total cost for taking soil core samples is the product of the number of samples taken, the hours required for each sample, and the labor rate.

21. Unit soil core sample analysis cost: The chemical analysis of each soil sample involves the measurement of 10 parameters (organic matter, total dissolved solids, total nitrogen, cadmium, arsenic, lead, mercury, chromium, zinc, and copper). Preparing each sample costs $10 and each parameter costs $5. Thus, the net cost per soil sample is $60.

22. Total soil core sample chemical analysis cost (Line 17 x Line 21): The total chemical analysis cost for the soil core samples is the product of the number of samples taken and the unit analysis cost per sample.

Lysimeter Sampling of Soil Moisture

23. Number of lysimeter samples: Soil moisture samples are taken by means of a lysimeter. This extracted water is then analyzed for contamination in the same way that the ground-water samples are chemically analyzed. Four soil moisture samples are taken during each quarter of the closure period. Since there are 5 quarters, a total of 20 samples are taken.

24. Labor hours required for each lysimeter collection of soil moisture: One hour of labor is required for collecting and handling each sample. This includes time spent moving about the field.

25. Labor unit cost for collecting samples: The unit labor cost for collecting these samples is $15 per hour fully-loaded.

26. Total sampling cost for lysimeter collection of soil moisture (Line 23 x Line 24 x Line 25): The total cost for collecting soil moisture samples is the product of the number of samples taken, the labor required for each sample, and the labor rate.

27. Unit cost for moisture sample analysis: The unit cost for each chemical analysis is $150. This is based on the land treatment facility's experience with ground-water contamination analysis and soil moisture chemical analysis.

28. Total cost for moisture sample chemical analysis (Line 23 x Line 27): The total cost for the soil moisture chemical analysis is the product of the number of samples taken and the cost of chemically analyzing each sample.

Administrative Costs

29. Number of technical hours for administration: The land treatment facility also requires the allocation of some technical supervisory labor to administer the closure monitoring program. Approximately two days of such supervisory labor will be required in small blocks of time expended throughout the closure period.

30. Person-hour technical costs: The fully-loaded labor cost for these technically qualified employees is $30 per hour.

31. Total technical costs for administration (Line 29 x Line 30): The cost of this technical administration is the product of the required technical administration hours and the technical labor rate.

32. Number of clerical hours: Clerical support is required for the monitoring administration activity. Two days of clerical labor will be needed in small blocks of time expended throughout the closure period.

33. Person-hour clerical cost: The fully-loaded labor rate for clerical labor at the land treatment facility is $8 per hour.

34. Total clerical costs (Line 32 x Line 33): The total clerical costs for administering the monitoring activity is the product of the hours required and the clerical labor rate.

35. Total administrative costs (Line 31 + Line 34): The technical and clerical administrative costs are added together to yield the total administrative costs for the monitoring program (both soil and ground-water) for the entire closure period.

Maintenance Costs

36. Monitoring well maintenance: The cost of maintaining the ground-water monitoring wells is estimated to be $750 for the entire closure period. No well replacements are anticipated during the closure period.

Cost Summaries for Monitoring

37. Total cost of ground-water monitoring (Line 9 + Line 16 + Line 36): The total cost for ground-water monitoring is the sum of the costs of sample collection, chemical analyses, and monitoring well maintenance.

38. Total cost of soil core sample monitoring (Line 20 + Line 22): The total cost of soil core sample monitoring is the sum of the costs of collecting the samples and chemically analyzing the samples.

39. Total cost for soil moisture (lysimeter) monitoring (Line 26 + Line 28): The total cost for soil moisture monitoring by means of lysimeter samples is the sum of the costs of collecting the samples and chemically analyzing the samples.

40. Total administrative costs (Line 35): The total administrative costs, both clerical and technical, for the monitoring program are repeated here.

41. Total monitoring costs (Line 37 + Line 38 + Line 39 + Line 40): The total cost for the entire closure period monitoring program is the sum of the costs of ground-water monitoring, soil core testing, lysimeter testing, and the administrative costs. All of these costs are reliably known from the operating experience of the facility.

D. Fence Maintenance

For a land treatment facility consisting of 50 acres of active fields, assuming that the site is square, each side is 1475.8 feet. The perimeter of the site is then 5903.2 feet.

1. Length of fence to be replaced: Since the land treatment facility has a prolonged closure period and possible post-closure activities, it is necessary to maintain the security fence along the field perimeters in good condition. We have estimated that 10% of the fencing will be corroded and damaged to the point of requiring replacement.

2. Unit cost of replacing fence: The security fence is a galvanized metal 6-foot high chain link fence made of #9 wire. The installed unit cost of replacement sections is $13.06 per linear foot.

3. Total cost of replacing fence (Line 1 x Line 2): The cost of replacing the damaged fence sections is the product of the length of the fence needing replacement and the unit cost of replacement, for a total of $7705.

E. Repair of Drainage Channels

1. Length of drainage channels: The land treatment facility's drainage channels are an important part of the containment system. They channel run-off water to a surface impoundment. Our estimate is that 500 feet of these channels will have to be replaced during the closure period.

2. Channel volume per unit length: The channels have a square cross sectional area measuring 3 feet by 3 feet. This results in a volume of 0.33 cu. yds. per linear foot of channel length.

3. Channel excavation unit cost: The unit cost of excavating the channels with a backhoe is $.67 per cu. yd. This work would be performed by a contractor and is based on contractor estimates.

4. Total channel excavation cost (Line 1 x Line 2 x Line 3): This total cost is the product of the length of the drainage channels required, the volume per unit length, and the unit excavation cost.

5. Unit cost of hand grading: The inner surface of the channels must be shaped and prepared for seeding. This work is performed by hand at a unit cost of $.02 per sq. ft. This work will be performed by a contractor and is based on contractor estimates.

6. Channel surface area: The inside surface of the new channel is approximately 4500 sq. ft. in area. All of this area must be shaped and prepared.

7. Total cost of hand grading (Line 5 x Line 6): The total cost of this hand grading is the product of the unit cost and the surface area of the channels.

8. Total replanting cost: The total cost of seeding, fertilizing and mulching the channel surface is estimated at $50 by a contractor.

9. Total channel repair cost (Line 4 + Line 7 + Line 8): The total cost of channel repair is the sum of the excavation cost, hand grading cost and replanting cost.

F. Management Inspection of Land Treatment Facility Operations

1. Number of technical management person-hours required for each inspection: The prolonged closure period for the land treatment facility and the recurring operations of spreading and disking necessitate an inspection program conducted by facility management throughout the closure period. Each one of these inspections requires 8 hours of technical management time.

2. Inspection frequency: The inspections are conducted once per month throughout the closure period. On each inspection, the manager checks the progress of the facility operations: spreading, disking, sampling, decontamination, etc.

3. Duration of closure period: To allow the hazardous waste to decompose, the closure period must be 15 months in duration.

4. Total technical management person-hours required for inspections (Line 1 x Line 2 x Line 3): The technical hours required for the actual inspections are the product of the number of hours for each inspection and the total number of inspections required.

5. Person-hour costs for technical management duties: The person-hour cost for this technical supervisory labor is $30 per hour (fully-loaded labor rate).

6. Total technical management costs for inspections (Line 4 x Line 5): The technical cost for the inspections conducted throughout the closure period is the product of the total inspection technical hours and the technical labor rate.

7. Additional technical management labor required: A small amount of additional technical time will be required for managerial tasks associated with the inspections (such as writing reports). Approximately 8 percent to 10 percent of the inspection time is required for this additional work.

8. Total cost of additional technical management labor (Line 5 x Line 7): The cost of this additional technical labor is the product of the additional hours required and the technical labor rate.

9. Total cost of technical management labor (Line 6 + Line 8): The total cost of all the technical labor required is the sum of the labor directly spent on inspections and the labor related to inspections.

10. Number of clerical hours required: Clerical labor is needed to support the periodic inspections of the land treatment facility. Only a modest amount of clerical labor is required.

11. Person-hour costs for clerical labor: The labor rate for clerical labor at this facility is $8 per hour. (This is a fully-loaded labor rate.)

12. Total cost for clerical labor (Line 10 x Line 11): The total cost for the needed clerical labor is the product of the clerical hours and the clerical labor rate.

13. Total inspection cost (Line 9 + Line 12): The total cost of the inspection program is the sum of the technical labor costs and the clerical labor costs.

G. Professional Certification

1. Number of person-hours required for inspections: Approximately one week of professional time will be required to certify the proper closure of the land treatment facility. Most of this professional work will be an independent professional engineer as specified by the interim status regulations. The professional engineer will be assisted by a soil specialist who will evaluate the soil samples taken during the closure period.

2. Cost per person-hour: The contracted cost of these professionals is $75 per hour based on their current quotes for these services.

3. Total costs of professional engineer's time (Line 1 x Line 2): The total cost for these contracted professional services is the product of the number of hours required and the quoted hourly rate.

4. Number of technical hours required for administrative duties: The land treatment facility technical staff will need to devote 8 hours of time to administering this certification.

5. Person-hour costs for technical administrative duties: The fully-loaded labor rate for the technical staff is $30/hour.

6. Total administrative costs for technical labor (Line 4 x Line 5): The technical administrative costs for the land treatment facility is the product of the number of technical hours required and the technical labor rate.

7. Number of clerical hours required for administrative duties: Eight hours of clerical work are required to support the administration of the certification.

8. Person-hour costs for clerical administrative duties: The fully-loaded labor rate for clerical workers at this facility is $8/hour.

9. Total administrative costs for clerical labor (Line 7 x Line 8): The total clerical labor costs are the product of the labor rate and the number of hours required.

10. Total administrative costs (Line 6 + Line 9): The total administrative costs are the sum of the technical labor cost and the clerical labor cost.

11. Total certification costs (Line 3 + Line 10): The total cost for certification is the sum of the costs of the professional engineer

and the administrative costs.

H. Total Costs Plus Administration and Contingencies

Items 1 through 7 give the costs of each major closure function on each of the preceding worksheets. Line 8 is the total of Lines 1 through 7, $39,389.

7. Administration: All additional administration costs are computed by multiplying the subtotal (Line 8) by 15 percent.

8. Contingencies: Allowance for contingencies is computed by multiplying the subtotal (Line 8) by 15 percent.

9. Total costs of closure (Line 8 + Line 9 + Line 10): A grand total for land treatment facility closure costs is computed by adding together the costs from the worksheets and the allowances for additional administration and other contingencies.

LAND TREATMENT FACILITIES

WORKSHEET A - DISPOSING OF WASTE INVENTORY

Method of Disposal: Spreading on the Land Treatment Fields

1.	Maximum inventory to be disposed	5000 tons of liquid waste
2.	Run-off water to be disposed	5000 tons
3.	Total material to be disposed (Line 1 + Line 2)	10,000 tons
4.	Application rate (wet weight)	100 tons/acre
5.	Acreage utilized	50 acres
6.	Number of applications in the closure period	2
7.	Unit cost of spreading	$48/acre
8.	Total cost of spreading (Line 5 x Line 6 x Line 7)	$4800
9.	Number of diskings required during the closure period (excluding one disking for decontamination)	10
10.	Unit cost of disking (equipment cost and labor)	$4.80/acre
11.	Total cost of disking (Line 5 x Line 9 x Line 10)	$2400
12.	Total cost for disposing of inventory and run-off water (Line 8 + Line 11)	$7200

LAND TREATMENT FACILITIES

WORKSHEET B - DECONTAMINATING THE FACILITY

1.	Area of facility contaminated	1200 sq. yds.
2.	Depth of material removed	.33 yds. (1 ft.)
3.	Unit cost for removal (including machinery rental)	$1.60/cu. yd.
4.	Cost of removing the contaminated soil (Line 1 x Line 2 x Line 3)	$633.60
5.	Quantity of contaminated soil disposed on-site by landspreading	396 cu. yds. (481 tons)
6.	Quantity of contaminated soil disposed off-site	0
7.	Application rate	10 tons/acre
8.	Acreage utilized	50 acres
9.	Number of applications	1
10.	Unit cost of spreading (equipment cost and labor)	$6/acre
11.	Total cost for spreading the contaminated soil on the land treatment fields (Line 8 x Line 9 x Line 10)	$300
12.	Number of diskings carried out to assist in disposing of contaminated soil	1
13.	Unit cost of disking (equipment cost and labor)	$4.80/acre
14.	Total cost for disking the spread soil into the land treatment soil (Line 8 x Line 12 x Line 13)	$240
15.	Total cost of disposing of the contaminated soil (Line 4 + Line 11 + Line 14)	$1173.60
16.	Cost of decontaminating equipment	$1000
17.	Disposing of residues from equipment decontamination	$1000
18.	Total cost of decontaminating the facility (Line 15 + Line 16 + Line 17)	$3173.60

LAND TREATMENT FACILITIES

WORKSHEET C - MONITORING ACTIVITIES
(GROUND-WATER AND SOIL MONITORING)

Ground-Water Monitoring

1.	Number of wells monitored	8 wells
2.	Number of samples taken at each well (1 per cycle)	3 samples
3.	Total number of samples (Line 1 x Line 2)	24 samples
4.	Number of hours for collecting the sample (per sample)	2 hours
5.	Total number of hours for collecting the samples (Line 3 x Line 4)	48 hours
6.	Number of hours for preparing and delivering sample (per each sampling cycle of eight wells)	3 hours
7.	Total number of hours for preparing and delivering sample (Line 2 x Line 6)	9 hours
8.	Person-hour costs for collecting and handling samples	$15/hour
9.	Total ground-water sampling and collection costs ((Line 5 + Line 7) x Line 8)	$855
10.	Number of ground-water quality analyses	16 analyses
11.	Number of ground-water contamination analyses	24 analyses
12.	Unit cost of ground-water quality analysis	$77
13.	Unit cost of ground-water contamination analysis	$108
14.	Total ground-water quality analysis costs (Line 10 x Line 12)	$1232
15.	Total ground-water contamination analysis costs (Line 11 x Line 13)	$2592
16.	Total ground-water chemical analyses costs (Line 14 + Line 15)	$3824

Soil Monitoring

Soil Core Sampling:

17.	Number of soil core samples taken during the closure period	66 samples
18.	Labor hours required for each core sample (includes movement between sampling locations)	.5 hours
19.	Labor unit cost for collecting core sample	$15/hour

WORKSHEET C (continued)

20.	Total cost of collecting soil samples for the entire closure period (Line 17 x Line 18 x Line 19)	$495
21.	Unit soil core sample analysis cost (10 parameters)	$60
22.	Total soil core sample chemical analysis cost (Line 17 x Line 21)	$3960
	Lysimeter Sampling of Soil Moisture:	
23.	Number of lysimeter samples taken during the closure period	20
24.	Labor hours required for each lysimeter collection of soil moisture	1 hour
25.	Labor unit cost for collecting samples	$15/hour
26.	Total sampling cost for lysimeter collection of soil moisture (Line 23 x Line 24 x Line 25)	$300
27.	Unit cost for moisture sample analysis	$150
28.	Total cost for moisture sample chemical analysis (Line 23 x Line 27)	$3000
Administrative Costs		
29.	Number of technical hours for administration	16 hours
30.	Person-hour technical costs	$30/hour
31.	Total technical costs for administration (Line 29 x Line 30)	$480
32.	Number of clerical hours	16 hours
33.	Person-hour clerical cost	$8
34.	Total clerical costs (Line 32 x Line 33)	$128
35.	Total administrative costs (Line 31 + Line 34)	$608
Maintenance Costs		
36.	Monitoring well maintenance (includes maintenance of associated equipment)	$750
Cost Summaries for Monitoring		
37.	Total cost of ground-water monitoring for the closure period (Line 9 + Line 16 + Line 36)	$5429
38.	Total cost of soil core sample monitoring for the closure period (Line 20 + Line 22)	$4455

WORKSHEET C (continued)

39.	Total cost for soil moisture (lysimeter) monitoring for the closure period (Line 26 + Line 28)	$3300
40.	Total administrative costs (Line 35)	$608
41.	Total monitoring costs for the entire closure period (Line 37 + Line 38 + Line 39 + Line 40)	$13,792

LAND TREATMENT FACILITIES

WORKSHEET D - FENCE MAINTENANCE

1.	Length of fence to be replaced	590 feet
2.	Unit cost of replacing fence	$13.06/linear ft.
3.	Total cost of replacing fence (Line 1 x Line 2)	$7705

LAND TREATMENT FACILITY

WORKSHEET E - REPAIR OF DRAINAGE CHANNELS

1.	Length of drainage channels requiring excavation	500 feet
2.	Channel volume per unit length	.33 cu. yds. per linear ft.
3.	Channel excavation unit cost	$.67/cu. yd.
4.	Total channel excavation cost (Line 1 x Line 2 x Line 3)	$11.05
5.	Unit cost for hand grading	$.02/sq. ft.
6.	Channel surface area to be prepared by hand	4500 sq. ft.
7.	Total cost of hand grading (Line 5 x Line 6)	$90
8.	Total replanting cost (including seed, fertilizer and mulch)	$50
9.	Total channel repair cost (Line 4 + Line 7 + Line 8)	$250.55

LAND TREATMENT FACILITIES

WORKSHEET F - MANAGEMENT INSPECTION OF LAND TREATMENT FACILITY OPERATIONS

1.	Number of technical management person-hours required for each inspection of the land treatment facility	8 hours
2.	Inspection frequency	1 per month
3.	Duration of closure period	15 months
4.	Total technical management person-hours required for inspections during the closure period (Line 1 x Line 2 x Line 3)	120 hours
5.	Person-hour costs for technical management duties	$30
6.	Total technical management costs for land treatment facility inspections (Line 4 x Line 5)	$3600
7.	Additional technical management labor required related to the inspection program	10 hours
8.	Total cost of the additional technical management labor (Line 5 x Line 7)	$300
9.	Total cost of technical management labor (Line 6 + Line 8)	$3900
10.	Number of clerical hours required	8 hours
11.	Person-hour costs for clerical labor	$8
12.	Total cost for clerical labor (Line 10 x Line 11)	$64
13.	Total inspection cost (Line 9 + Line 12)	$3964

LAND TREATMENT FACILITIES

WORKSHEET G - PROFESSIONAL CERTIFICATION

1.	Number of person-hours required for inspecting the land treatment facility and its operating records	40 hours
2.	Cost per person-hour	$75
3.	Total costs of professional engineer's time (Line 1 x Line 2)	$3000
4.	Number of technical hours required for administrative duties	8 hours
5.	Person-hour costs for technical administrative duties	$30
6.	Total administrative costs for technical labor (Line 4 x Line 5)	$240
7.	Number of clerical hours required for administrative duties	8 hours
8.	Person-hour costs for clerical administrative duties	$8/hour
9.	Total administrative costs for clerical labor (Line 7 x Line 8)	$64
10.	Total administrative costs (Line 6 + Line 9)	$304
11.	Total certification cost (Line 3 + Line 10)	$3304

LAND TREATMENT FACILITIES

WORKSHEET H - TOTAL COSTS PLUS ADMINISTRATION AND CONTINGENCIES

1.	Cost of disposing of inventory (From Worksheet A)	$ 7,200
2.	Cost of decontaminating the facility (From Worksheet B)	$ 3,173
3.	Cost of monitoring (From Worksheet C)	$13,792
4.	Cost of fence maintenance (From Worksheet D)	$ 7,705
5.	Cost of repairing drainage channels (From Worksheet E)	$ 251
6.	Cost of management inspections (From Worksheet F)	$ 3,964
7.	Cost of professional certification of closure (From Worksheet G)	$ 3,304
8.	Total of Line 1 through Line 7	$39,389
9.	Administration	$ 5,908
10.	Contingencies	$ 5,908
11.	Total costs of closure (Line 8 + Line 9 + Line 10)	$51,205

9.4 EXAMPLE - LANDFILLS

For illustrative purposes, a sample cost estimate has been developed for a landfill with the following characteristics: the landfill has been in operation for 10 years and covers approximately 75 acres. Sixty-five acres have been partially closed (i.e., they have been filled with waste, an adequate cap and vegetative cover established and maintained). Ten acres of the landfill are currently in active use and have not received final cap or cover but are largely filled. Of the 65 acres which have received final cap and cover, it is assumed that approximately 5 acres are in need of revegetation due to failure of original vegetation over the life of the facility. The landfill accepts hazardous solid waste received in trucks. Waste is received for this site in 55-gallon drums.

SAMPLE CLOSURE COST ESTIMATING WORKSHEETS - LANDFILLS

A. Disposing of Inventory

1. Volume of waste when processed for landfill disposal: It is estimated from the closure plan that the most expensive closure conditions likely to occur over the life of facility would result in 900 55-gallon drums of waste to be disposed and no trench yet constructed for their disposal. This situation would occur when existing trenches had been filled but not yet capped, and waste continued to be accepted for further disposal. This estimate should be based on the volume of the waste after conducting the necessary processing prior to disposal. For example, if sludge is taken in, the proper volume to be used is that of solidified sludge, not the volume of the sludge as it enters the facility. In this case, since waste is accepted in drums only, there is no need for further calculation.

2. Estimated volume of contaminated soil residues disposed of through on-site landfill operations: This volume is determined from Worksheet B.

3. Total volume of wastes to landfills on-site (Line 1 + Line 2): In this case, the total volume to be landfilled on-site is the volume of inventory (800 cu. yds.) plus the estimate volume of residues and contaminated material to be disposed of on-site from Worksheet B (600 cu. yds.). It is possible in some cases that not all inventory could be disposed of on-site. For example, if two wastes normally are neutralized by combination, and there is inadequate volume of one of the wastes to complete neutralizing the second waste at the time closure commences, some portion of the second waste would have to be disposed of off-site.

4. Estimated cost of constructing a trench: The cost of constructing a trench adequate for 1400 cu. yds. of material of the type indicated, including adequate liner, is estimated as $18,000, based upon past trench construction experience at the facility.

5. Estimated cost of placing wastes in trench (excluding final cover and vegetation): Based on the annual volume and operating costs of the facility (excluding profits and depreciation), it is estimated that the costs of placing this waste will be $6000.

6. Total cost of disposing of inventory (Line 4 + Line 5): The total cost of disposing of inventory are then the sum of Lines 4 and 5.

B. Decontaminating the Facility

1. Area of facility contaminated: It is assumed in the example that at the end of facility life, approximately 1800 sq. yds. of the surface of the facility will show sufficient contamination to justify its disposal as hazardous waste.

2. Depth of material removed: It is assumed that removal to 1 foot will be necessary.

3. Cost of removal: The assumed cost of removing this material is $1.40 per cu. yd. for a total cost of $840. This does not include the costs of disposing of the material.

4. Quantity disposed on-site: For the sample problem, it is assumed that all 600 cu. yds. will be disposed on-site.

5. Quantity disposed at an off-site TSDF: None of the material removed will be disposed off-site.

6. Cost to decontaminate equipment: It is assumed that $1000 will be sufficient for decontaminating equipment.

7. Volume of waste resulting from decontaminating equipment: It is estimated that 25 cu. yds. of material will need to be disposed of as a result of decontaminating equipment.

8. Unit cost of off-site disposal: Contact with other area hazardous waste disposal facilities indicates that land disposal for these wastes would currently cost $40/cu. yd.

9. Unit cost of hauling: Hauling this small quantity of residue 20 miles to nearest landfill will cost $10 per cu. yd. according to local trucking concerns.

10. Total cost of off-site disposal (Line 7 x Line 8): Total costs of disposing residue are then $1000.

11. Total cost of hauling (Line 7 x Line 9): Total cost of hauling is then the unit cost of hauling times the total volume of residues to be disposed.

12. Total cost of decontaminating the facility (Line 3 + Line 6 + Line 10 + Line 11): Total costs are then $2850.

- Placing Final Cap

As noted in the summary of this example, it has been assumed that the equipment for all necessary earth work is available on-site. As a result, costs for placing a final cap over the fill area include only labor, operating costs, and materials, not costs associated with renting equipment or capital recovery factors for purchased equipment.

1. Area to be capped: The example assumed that 10 acres, or 48,400 sq. yds., will remain open and require both a clay cap and topsoil.

2. Type of material used for impermeable layer: Clay is the impermeable material specified in the closure plan.

3. Depth of impermeable layer: It is assumed that 2 ft. of clay will provide an adequate cap.

4. Volume of material required (Line 1 x Line 3): The amount of clay required is 32,428 yds. (48,400 x .67 yds.).

5. Source of impermeable material: It is assumed that clay is available on-site as a result of previous excavations, at a haul distance of 800 yds. or less.

6. Cost of impermeable material: Because the material is available on-site, the cost is zero.

7. Depth of topsoil required: It is assumed that 2 ft. of topsoil will be adequate to ensure that the roots from vegetation of the fill area do not penetrate the clay cap.

8. Volume of topsoil required (Line 1 x Line 7): The amount of topsoil required is 32,428 cu. yds.

9. Source of topsoil: Again, it is assumed that adequate topsoil is available on-site from previous excavations.

10. Cost of topsoil: The cost in this case is zero, since the material is available on-site. (If topsoil were not available on-site, a cost estimate would have to be developed through discussions with local suppliers, etc.)

11. Cost per cu. yd. for hauling, spreading and compacting clay and topsoil: In the example, it is assumed that this can be done for $1.20 per cu. yd.

12. Cost of placing impermeable portion of cap (Line 4 x Line 11): Based on these assumptions, the costs of placing the impermeable portion

of the cap would be $38,914.

13. Cost of placing topsoil (Line 8 x Line 11): Based on the assumptions, the costs of placing topsoil are also $38,914.

14. Total costs of final cap (sum of Lines 6, 10, 12, and 13): The total costs of the final capping operation will be $77,828. This does not include administrative expenses or contingency planning, both of which are calculated on Worksheet G.

D. Planting Final Vegetation

As in the above worksheets, it is assumed that all necessary equipment is available on-site, but that material and labor costs will be accrued during the closure exercise.

1. Area not yet vegetated: The area remaining open at the time of closing is 10 acres.

2. Area already closed but requiring replanting: It is assumed in this case that 5 acres of the closed portion of the landfill require replanting, due to the failure of original vegetation efforts.

3. Total area to be planted (Line 1 + Line 2): The sample case provides for 15 acres to be planted during closure.

4. Type of vegetation to be used: In this example, it is assumed that coarse field grass (a mixture of rye grass and Kentucky fescue) will be employed for final vegetation.

5. Quantity of seed used per acre: According to industry suppliers, 150 lbs. of seed should be applied per acre.

6. Cost of seed per pound: Calls to local suppliers determined that seed is available at $.50/lb.

7. Total cost of seed (Line 3 x Line 5 x Line 6): Given the above assumptions, the total cost of seed will be $1125.

8. Type of fertilizer to be used: Given the topsoil and climatic conditions, 10/10/10 fertilizer is assumed to be adequate.

9. Quantity of fertilizer per acre: .25 tons is assumed to be reasonable, given the quality of topsoil and the climatic conditions.

10. Cost of fertilizer per ton: According to local suppliers, fertilizer is available for $200/ton.

11. Total cost of fertilizer (Line 3 x Line 9 x Line 10): Given the above assumptions, the total cost of fertilizer is $750.

12. Cost of soil preparation per acre: Preparing the soil includes both disking and fertilizing and is assumed to be $100 per acre.

13. Total cost of preparing soil (Line 3 x Line 12): The total cost of preparing soil, excluding materials such as fertilizers, is, given the above assumptions, $1500.

14. Cost per acre of seeding (excluding cost of seed): It is assumed for the sample facility that seeding will cost $150 per acre.

15. Total cost of seeding (excluding seed) (Line 3 x Line 14): Given the above assumptions, the total cost of seeding for the facility is $2250.

16. Cost per acre of mulching: The cost per acre of purchasing and applying a hay mulch is assumed to be $120.

17. Total mulching costs (Line 3 x Line 16): Given the above assumptions, total mulching costs, including costs of hay, are $1800 for the

18. Total costs for vegetation (sum of Lines 7, 11, 13, 15, and 17): The total costs for establishing vegetation are $7425.

E. Ground-Water Monitoring

Assume that closure of the landfill will require a total of 90 days. In order to determine the maximum possible ground-water monitoring costs, the most extensive monitoring needed at closure is assumed. Assuming that ground-water quality analyses are required annually and ground-water contamination analyses are required semi-annually, the most expensive case is that in which both sets of analyses are required during the 90-day closure period.

1. Number of wells monitored: For the sample landfill, it is assumed that eight wells would need to be monitored.

2. Number of samples per well: One sample is taken per well for both analyses.

3. Total number of samples (Line 1 x Line 2): Given the above assumptions, eight samples are required.

4. Number of hours required for collecting the sample: It is assumed that experience has shown that 2 hours are sufficient to gather samples from each well.

5. Total number of hours required for collecting the samples (Line 3 x Line 4): For eight samples, 16 hours are required for collecting the samples.

6. Number of hours required for preparing and delivering the sample: It is assumed for the example that experience has shown that this can be done in 3 hours.

7. Person-hour costs for collecting samples: Assume that the fully-loaded costs for labor required for collecting, preparing and delivering the sample averages $15 per hour.

8. Total sampling and collecting costs ((Line 5 + Line 6) x Line 7): This results in total sampling and collection costs of $285.

9. Number of ground-water quality analyses: One analysis must be made for each well sample, for a total of eight.

10. Number of ground-water contamination analyses: One analysis must be made for each well sample, for a total of eight.

11. Unit cost of ground-water quality analysis. It is assumed that the cost of an analysis for the following parameters is $77 per sample:

Chloride	$ 6/sample
Iron	$12/sample
Manganese	$12/sample
Phenols	$25/sample
Sodium	$12/sample
Sulfate	$10/sample

12. Cost of ground-water contamination analysis. It is assumed that an analysis for the following parameters is $108 per sample:

pH	$ 4/sample
Specific Conductance	$ 4/sample
Total Organic Carbon	$25/sample
Total Organic Halogen	$75/sample

13. Total ground-water quality analysis costs (Line 9 x Line 11): For eight samples at $77 per analysis, this yields a total cost of $616.

14. Total ground-water contamination analysis costs (Line 10 x Line 12): For eight samples at $108 per analysis, this yields a total cost of $864.

15. Total analysis costs (Line 13 + Line 14): The total analyses costs, therefore, are $1480.

16. Number of technical hours for administration: This includes all time necessary to administer and report the data from the analyses and is estimated as 8 hours.

17. Person-hour technical costs: The fully-loaded cost required for this work is assumed to be $30 per hour.

18. Total technical costs for administration (Line 16 x Line 17): Given the above assumptions, total costs for administering the tests are assumed to be $240.

19. Number of clerical hours: Assume for this case that 5 hours of clerical time are required to produce the necessary reports.

20. Per-hour clerical costs: Assume the fully-loaded costs for clerical work are $8 per hour.

21. Total administrative costs (Line 19 x Line 20): Given the above assumptions, the total clerical costs are $40.

22. Total administrative costs (Line 18 + Line 21): The sum of technical and clerical costs are then $280.

23. Monitoring equipment maintenance: It is assumed that an average of $150 is required for a 90-day period to ensure adequate maintenance of monitoring equipment and wells.

24. Total monitoring costs (sum of Lines 8, 15, 22, and 23): Total monitoring costs, excluding administration and contingencies, are then $2195.

F. Fence Maintenance

For a 75-acre site, assuming that the site is square, each side of the site is 1807 feet in length. The perimeter of the site is then 7228 feet.

1. Length of fence to be replaced: It is expected that some sections of the facility's security fence will have corroded and will have to be replaced. Our estimate is that 10% of the perimeter fence will have to be replaced.

2. Unit cost of replacing fence: The security fence around the facility perimeter is a galvanized metal chain link fence 6 feet high. This fence is made of #9 wire. The unit replacement cost for this fence is $13.06 per linear foot.

3. Total cost of replacing fence (Line 1 x Line 2): The cost of fence replacement is the product of the length of fence needing replacement and the unit cost of replacement, for a total of $9442.

G. Professional Certification

1. Number of person-hours required for inspections: It is assumed that 80 hours are required for periodically inspecting all aspects of closure of the landfill.

2. Cost per person-hour: In this case, assume that a registered independent professional engineer may be hired at a cost of $75 per hour.

3. Total costs of independent professional engineer's time (Line 1 x Line 2): This yields a total cost of $6000 for the independent professional engineer.

4. Number of technical hours required for administrative duties: Assume that 8 hours are required from the owner/operator's staff for administrative duties connected with employing an independent professional engineer.

5. Person-hour costs for technical administrative duties: It is assumed that the total fully-loaded costs for the owner/operator's staff are $30 per hour.

6. Total administrative costs for technical labor (Line 4 x Line 5): Given the above assumptions, the total administrative costs for technical labor are $240.

7. Number of clerical hours required for administrative duties: Assume that 5 hours of clerical time are required for the necessary typing and certifications.

8. Person-hour costs for clerical administrative duties:. Fully-loaded costs of clerical time are assumed to be $8.

9. Total administrative costs for clerical labor (Line 7 x Line 8): Given the above assumptions, total clerical costs are $40.

10. Total administrative costs (Line 6 + Line 9): Summing technical and clerical labor, the total administrative costs are $280.

11. Total certification costs (Line 3 + Line 10): The total costs for certification, including the engineer's fees and administrative costs, is then $6280.

H. Total Closure Costs Including Administration and Contingencies

Lines 1 through 7 of this Worksheet simply summarize the total closure costs, excluding administration and contingencies, from each of the prior worksheets.

8. Total of Lines 1 through 7: The total costs for the activities listed in Lines 1 through 7 are $130.020.

9. Administration: For administrative tasks, including taxes, insurance, and administration and supervision not included elsewhere, a total of 15 percent of total costs from Line 8 is used.

10. Contingencies: A general provision for contingencies of 15 percent of total costs has been included.

11. Total closure costs (Line 8 + Line 9 + Line 10): The estimated total closure costs are then $169,026.

LANDFILLS

WORKSHEET A - DISPOSING OF INVENTORY

1.	Volume of waste when processed for disposal	800 cu. yds.
2.	Estimated volume of residue and contaminated soil to be disposed through on-site landfill operation	600 cu. yds.
3.	Total volume of waste to be landfilled on-site (Line 1 + Line 2)	1400 cu. yds.
4.	Estimated cost of constructing trench	$18,000
5.	Estimated cost of placing waste in trench	$ 6,000
6.	Total cost of disposing of inventory (Line 4 + Line 5)	$24,000

LANDFILLS

WORKSHEET B - DECONTAMINATING THE FACILITY

1.	Area of facility contaminated	1800 sq. yds.
2.	Depth of material removed	.33 yd. (1 ft.)
3.	Cost of removal	$840
4.	Quantity disposed on-site (see Worksheet A to develop cost)	600 cu. yds.
5.	Quantity disposed off-site	0
6.	Cost to decontaminate equipment	$1000
7.	Volume of waste resulting from decontaminating equipment	25 cu. yds.
8.	Unit cost of off-site disposal ($/cu. yd.)	$40
9.	Unit cost of hauling ($/cu. yd.)	$10
10.	Total cost of disposing off-site (Line 7 x Line 8)	$1000
11.	Total cost of hauling (Line 7 x Line 9)	$250
12.	Total costs of decontaminating the facility (Line 3 + Line 6 + Line 10 + Line 11)	$2850

LANDFILLS

WORKSHEET C - PLACING FINAL CAP

1.	**Area to be capped (include sum of all portions of the facility remains open and any portions of the facility opened to dispose of inventory and wastes from the process of decontamination)**	**48,400 sq. yds. (10 acres)**
2.	**Type of material used for impermeable layer**	**Clay with permeability of 10^{-7}**
3.	**Depth of material of impermeable layer**	**.667 yds. (2 ft.)**
4.	**Volume of material to be used for impermeable layer (Line 1 x Line 3)**	**32,428 cu. yds.**
5.	**Source of impermeable material**	**On-site from previous excavations**
6.	**Cost of impermeable material**	**0**
7.	Depth of topsoil	.667 yds. (2 ft.)
8.	Volume of topsoil (Line 1 x Line 7)	32,428 cu. yds.
9.	Source of topsoil	On-site from previous excavations
10.	Cost of topsoil	0
11.	Cost per cu. yd. for hauling, spreading and compacting	$1.20
12.	Cost of impermeable portion of cap (Line 4 x Line 11)	$38,914
13.	Cost of placing topsoil (Line 8 x Line 11)	$38,914
14.	Total costs (Line 6 + Line 10 + Line 12 + Line 13)	$77,828

LANDFILLS

WORKSHEET D - PLANTING FINAL VEGETATION

1.	Area not yet vegetated (should be approximately equivalent to area remaining open)	10 acres
2.	Area already closed but in need of some replanting prior to final closure	5 acres
3.	Total area to be planted (Line 1 + Line 2)	15 acres
4.	Type of vegetation to be used	Coarse grass
5.	Quantity of seed per acre	150 lbs.
6.	Cost of seed per pound	$.50
7.	Total cost of seed (Line 3 x Line 5 x Line 6)	$1125
8.	Type of fertilizer to be used	10/10/10
9.	Quantity of fertilizer per acre	.25 tons
10.	Cost of fertilizer per ton	$200
11.	Total cost of fertilizer (Line 3 x Line 9 x Line 10)	$750
12.	Cost of soil preparation per acre	$100
13.	Total cost of preparing soil (excluding materials) (Line 3 x Line 12)	$1500
14.	Cost per acre of seeding (less materials)	$150
15.	Cost of seeding (Line 3 x Line 14)	$2250
16.	Cost per acre of mulching	$120
17.	Total mulching costs (Line 3 x Line 16)	$1800
18.	Total costs for vegetation (Line 7 + Line 11 + Line 13 + Line 15 + Line 17)	$7425

LANDFILLS

WORKSHEET E - GROUND-WATER MONITORING

1.	Number of wells monitored	8 wells
2.	Number of samples per well	1 sample
3.	Total number of samples (Line 1 x Line 2)	8 samples
4.	Number of hours required for collecting sample (per sample)	2 hours
5.	Total number of hours required for collecting samples (Line 3 x Line 4)	16 hours
6.	Number of hours required for preparing and delivering samples	3 hours
7.	Person-hour costs for collecting samples	$15
8.	Total sampling and collection costs ((Line 5 + Line 6) x Line 7)	$285
9.	Number of ground-water quality analyses	8 analyses
10.	Number of ground-water contamination analyses	8 analyses
11.	Unit cost of ground-water quality analysis	$77
12.	Cost of ground-water contamination analysis	$108
13.	Total ground-water quality analysis costs (Line 9 x Line 11)	$616
14.	Total ground-water contamination analysis costs (Line 10 x Line 12)	$864
15.	Total analyses costs (Line 13 + Line 14)	$1480
16.	Number of technical hours for administration (e.g., reporting data to EPA)	8 hours
17.	Person-hour technical costs	$30
18.	Total technical costs for administration (Line 16 x Line 17)	$240
19.	Number of clerical hours	5 hours
20.	Person-hour clerical costs	$8
21.	Total clerical costs (Line 19 x Line 20)	$40
22.	Total administrative costs (Line 18 ÷ Line 21)	$280

WORKSHEET E - continued

23.	Monitoring equipment maintenance	$150
24.	Total monitoring costs (Line 8 + Line 15 + Line 22 + Line 23)	$2195

LANDFILLS

WORKSHEET F - FENCE MAINTENANCE

1.	Length of fence to be replaced	723 feet
2.	Unit cost of replacing fence	$13.06/ linear ft.
3.	Total cost of replacing fence (Line 1 x Line 2)	$9442

LANDFILLS

WORKSHEET G - PROFESSIONAL CERTIFICATION

1.	Number of person-hours required for inspections	80 hrs.
2.	Cost per person-hour	$75
3.	Total costs of independent professional engineer certification (Line 1 x Line 2)	$6000
4.	Number of technical hours required for administrative duties	8 hrs.
5.	Person-hour costs for technical administrative duties	$30
6.	Total administrative costs for technical labor (Line 4 x Line 5)	$240
7.	Number of clerical hours required for administrative duties	5 hrs.
8.	Person-hour costs for clerical administrative duties	$8
9.	Total administrative costs for clerical labor (Line 7 x Line 8)	$40
10.	Total administrative costs (Line 6 + Line 9)	$280
11.	Total certification costs (Line 3 + Line 10)	$6280

LANDFILLS

WORKSHEET H - TOTAL COSTS OF CLOSURE INCLUDING ADMINISTRATION AND CONTINGENCIES

1.	Cost of disposing of inventory (From Worksheet A)	$ 24,000
2.	Cost of decontaminating the surface and ancillary facilities (From Worksheet B)	$ 2,850
3.	Cost of placing the final cap (From Worksheet C)	$ 77,828
4.	Cost of planting final vegetation (From Worksheet D)	$ 7,425
5.	Cost of ground-water monitoring (From Worksheet E)	$ 2,195
6.	Cost of fence maintenance (From Worksheet F)	$ 9,442
7.	Cost of professional certification (From Worksheet G)	$ 6,280
8.	Total of Line 1 through Line 7	$130,020
9.	Administration	$ 19,503
10.	Contingencies	$ 19,503
11.	Total costs of closure (Line 8 + Line 9 + Line 10)	$169,026

9.5 EXAMPLE - INCINERATORS

A 12-acre incinerator facility has bulk storage facilities for 120,000 gallons of slop oil, 120,000 gallons of phenolic wastewater, and 1,000,000 gallons of organic sludge. Waste is also delivered in 55-gallon drums; a maximum of 600 drums may be stored at the facility. In addition to these delivered wastes, the facility normally contains an inventory of 50 drums of non-combustible ash from the incinerator.

The incinerator is designed to operate at 16 gpm with the following feed mixture: 4 gallons of slop oil, 4 gallons of wastewater, and 8 gallons of sludge (a 1/1/2 ratio). The total operating horsepower of the incinerator (including pollution control equipment in the form of a caustic scrubber used to remove chlorinated compounds emitted from the slop oil) is 350 HP. The following worksheets are based on this facility description.

SAMPLE CLOSURE COST ESTIMATING WORKSHEETS: INCINERATORS

A. Characterizing the Waste Inventory

Worksheet A is used to describe each waste accepted at the site. For the example, worksheets must be prepared for each of the following wastes: slop oil, phenolic wastewater, and biological treatment sludges. For each waste product accepted, the following information is required:

1. Describing the waste: Describing the origin and general nature of the waste.

2. Chemical composition: Chemical composition should be expressed in weight percents for major components and parts per million (ppm) for trace components. This information should be readily available to the operator from the bill of lading for each waste shipment.

3. Physical state of the waste: This describes whether the waste is a liquid, solid, or mixture. This information is utilized in making estimates of solid residues requiring disposal (Worksheet B).

4. Heat of combustion of the waste: The heat content (expressed in BTU/lb., or BTU/gal.) of the waste products. This information is used in determining auxiliary fuel requirements (if any) on Worksheet C.

5. Specific gravity of the waste: The specific gravity of the waste at 60°F referenced to water at 60°F is used in the example problem.

6. Closure inventory: For the example, it has been assumed that the operator has identified from experience that the maximum inventory he has ever had stored on-site was a 14-day backlog. We will assume that this inventory is comprised of the total components: 224 drums of slop oil (12,320 gallons), 224 drums of phenolic wastewater (12,320 gallons) and 152 drums of sludges (8,360 gallons); the bulk storage tanks contain 28,000 gallons of slop oil, 28,000 gallons of phenolic wastewater, and 233,560 gallons of organic sludges. Under these conditions, the incinerator will be able to treat its inventory through seven days of burning its optimum feed mixture, and seven days of burning sludges alone (through the addition of auxiliary fuels).

B. Treating the Inventory

It is assumed that the inventory on-hand at the time of closure will be incinerated on-site. All equipment necessary for the operation of the incinerator is assumed to be in complete working order.

1. Time required for treating the inventory: It will require 336 hours (322,560 gallons of waste ÷ 960 gallons throughput per hour). If it is further assumed that the incinerator is on-stream 90% of the time, the total time required for treating on-site inventory is 373 hours.

2. Manpower requirements for treating the inventory: The total number of personnel required to operate this facility (including plant operators, equipment operators, guards, maintenance persons, and laboratory personnel) is estimated as six. Therefore, total man-hour requirement for treating the inventory is 2238 hours.

3. Cost of manpower: The average hourly wage rate of a plant operator (including fringe benefits and labor burdens) is assumed to be $20.

4. Total costs of operating labor during inventory treatment (Line 2 x Line 3): Given the above assumptions, labor costs for this phase of closure are $44,760.

5. Fuel requirements for treating the inventory: These represent both the cost of utilities consumed in order to treat the waste inventory, plus any auxiliary fuels which had to be purchased. Each of these items is separately costed below.

6. Electricity requirements for treating the inventory: The incinerator is actually in operation for 336 hours. Electricity requirements for the example are equal to 350 HP x .746 $\frac{KW}{HP}$ x 336 hours = 87,730 kwh.

7. Costs of electricity: Electricity is assumed to be available at a cost of $.06/kwh.

8. Total costs of electricity (Line 6 x Line 7): Total electricity costs for the example are $5264.

9. Auxiliary fuel requirements: During the first 168 hours of inventory treatment, the incinerator will be receiving an input feed of 25% slop oil, 25% phenolic wastewater, and 50% organic sludges. This feed has a heat value of 2900 BTU/lb. and will burn autogenously. During the remaining 168 hours, the feed will be comprised entirely of sludges, with a heat value of 700 BTU/lb.; this mixture does require auxiliary fuel inputs.

10. Type of auxiliary fuel used: It is assumed that #6 fuel oil is used as the auxiliary fuel.

11. Quantity of fuel required: Using engineering analysis, and assuming an average heat value of 154,000 BTU/gal. for fuel oil, total auxiliary fuel requirements are estimated at 10,456 gallons.

12. Cost of auxiliary fuel: It is assumed that #6 fuel oil is available to the operator at $.90 per gallon.

13. Total cost of auxiliary fuels (Line 11 x Line 12): The total cost of auxiliary fuel inputs is $9410.

14. Total fuel costs (Line 8 + Line 13): Total fuel costs are $14,674.

15. Chemical requirements: This category includes all chemicals, catalysts, adsorbents, and other supplies consumed during inventory treatment. In the example, the only chemical required is the caustic consumed during flue gas scrubbing of chlorine entrained in the incinerator waste stream.

16. Type of chemicals used: It is assumed that the caustic will be purchased as a 50% solution.

17. Quantity of chemicals required: There are 40,320 gallons of slop oil in the waste inventory assumed to be present at the time of closure. This is equivalent to 319,334 lbs. of slop oil (40,320 x .95 specific gravity of slop oil x 8.34 lbs./gal. water). Since the chlorine content of the slop oil is assumed to be no greater than 3 percent, the maximum quantity of chlorine to be scrubbed is 9,580 lbs. (270 moles). Assuming that 1 mole of NaOH is required to neutralize 1 mole of chlorine, 270 moles x 40 lbs. NaOH/mole = 10,800 lbs. NaOH consumption.

18. Cost of chemicals required: Caustic is assumed to cost $.0825/ dry lb.

19. Total cost of chemicals (Line 17 x Line 18): The total cost of chemicals consumed during inventory treatment is $891.

20. Disposing or treating residues generated during inventory treatment: The residue generated during inventory treatment is a powdery solid, incinerator ash. The ash has a specific gravity of 2.5.

21. Amount of residue on-site after treating the inventory: There are 50 55-gallon drums of ash stored on-site at the point of closure (each weighing 1150 lbs., for a total of 57,500 lbs.). In addition, residues

are generated by processing the waste inventory. The sludges incinerated in the example are assumed to be 10 percent solids; one-third of the solids are assumed to be non-combustible. The slop oil and wastewaters processed by the incinerator produce no ash. Therefore, the amount of new residue generated = (total amount of sludge in inventory times specific gravity of the non-combustible portion of the materials times the portion of the sludge that is non-combustible), or:

241,920 x (2.5 x 8.34) x .0333 = 167,968 lbs.

Total residue to be disposed of is equal to 167,968 lbs. and 57,500 lbs. = 225,468 lbs.

22. Method of disposing of ash: It is assumed that the incinerator ash is put into drums and transported to a secure landfill. The residue generated during inventory treatment can be placed in 146 drums, making the total number of drums to be disposed of 196.

23. Unit costs of disposing of residue: The costs of disposing in a landfill are assumed to be $50/drum, according to industry specialists.

24. Total costs of disposing of residue (Line 21 x Line 23): Total costs for the sample case are $9800.

25. Costs of hauling residue to landfill for disposal: In the example, it is assumed that the nearest landfill that will accept the drummed residue is 50 miles away, and that trucks with a carrying capacity of 40 drums are rented at an hourly cost of $60. At a speed of 40 mph, and assuming four hours for loading/unloading each trip, the total hauling costs are estimated at $1950.

26. Total cost of treating and disposing of inventory (sum of Lines 4, 14, 19, 24, and 25): Given the above assumptions, the total cost of inventory disposal will be $72,075.

C. Decontaminating the Facility

In order to completely decontaminate the incinerator facility, the operator must see to it that all storage tanks and liquid waste feed lines are cleaned, that wastewaters from the cleaning process are properly disposed or treated, that all equipment structures and containers left on-site are decontaminated, and that all contaminated soil is removed properly. These various activities are individually costed below.

Tank Cleaning

1. Storage tank cleaning: The total volume of storage capacity to be cleaned is 1,240,000 gallons (120,000 gallons of slop oil storage, 120,000 gallons of phenolic wastewater storage, and 1,000,000 gallons of organic sludge storage).

2. Method used: The cleaning method selected for the sample case is steam-cleaning.

3. Unit cost of cleaning: Renting equipment, labor, and operating costs for 1600 gal./hour of cleaning equipment are assumed to be approximately $.02/gal. of capacity cleaned, based on information from the Means construction cost guide.

4. Total costs of storage tank cleaning (Line 1 x Line 2): Total costs of steam-cleaning the storage facility are $24,800, given the above assumptions.

5. Cleaning residue generation: According to closure guidelines for waste treatment sites issued by the Texas Department of Water Resources, the amount of contaminated washwaters produced by steam-cleaning can be assumed to be equal to .125 times the volume of the tank being cleaned.

6. Quantity of cleaning residue generated (Line 1 x Line 5): 155,000 gallons of contamined washwater are generated in the example.

7. Method of disposing of residue: In the sample case, residues are assumed to be transported by tank truck to a surface impoundment for evaporation.

8. Unit costs for disposing of residues: Based on waste disposal industry estimates, it will cost $.05/gal. to dispose of residues in an impoundment.

9. Total costs for disposing of residues (Line 6 x Line 8): Total costs of cleaning residue disposal, given these assumptions, are $7750.

10. Hauling costs for residues: In the example, hauling cost estimates are based on the following assumptions - the distance between the incinerator and the surface impoundment is 100 miles one-way, a 7000-gallon trailer is used, the average trip speed is 40 mph, and the hourly rental cost of truck and driver is $60. The cost of one round trip is $300.

11. Number of trips required: The number of trips required for the case is 23.

12. Total hauling costs for residues (Line 10 x Line 11): The hauling costs for residue disposal are estimated at $6900.

Decontaminating the Facility

13. Flush out liquid waste feed lines: The estimated cost of flushing out all liquid residues from feed lines on the facility (before the storage areas and incinerators are cleaned) is assumed to be roughly one-eighth of the costs of tank cleaning, or $3000.

14. Pump out and backfill sumps: Sumps are to be decontaminated to prevent the possibility of rain water accumulating and contaminating these portions of the facility. The estimated costs of this activity are $2000.

15. Removing contaminated soils: Because of spills and other accidental releases, certain areas of the waste disposal site such as the dikes in areas around storage tanks may be contaminated. We have assumed in this example problem that 2.5 percent of the area of the site (exclusive of reservoirs, ponds, and basins) is contaminated.

Contaminated area = .025 x 12 acres x 4840 sq. yd./acre
= 1452 sq. yds.

16. Depth of soil removal: For this example, the assumed depth of soil removal is one foot.

17. Total amount of soil removed (Line 15 x Line 16): The total amount of soil removed in this example is (1452 x .333), or 484 cu. yds.

18. Unit cost of removing soil: Costs of removing soil (including equipment rental) are estimated at $1.60/cu. yd.

19. Total cost of soil removal (Line 17 x Line 18): Given the above assumptions, the cost of removing the contaminated soil from the incinerator site is $774.

20. Costs for disposing of contaminated soils: The contaminated soil is assumed to be disposed in a sanitary landfill. Based on current estimates, the soil can be landfilled at a cost of $30/ton.

21. Total cost of disposing of soil (Line 17 x Line 20): The cost of disposing of the contaminated soil is $14,520.

22. Hauling costs for contaminated soil: In this example, the nearest landfill is assumed to be 50 miles away, the truck used for hauling

has a carrying capacity of 44,000 lbs., and is rented at a hourly cost of $60.

23. Number of trips required: Assuming an average speed of 40 mph, 22 trips will be required.

24. Total hauling costs for contaminated soil (Line 22 x Line 23): Given the above assumptions, the total costs for hauling the contaminated soil are $3300.

25. Total costs of decontaminating the facility (sum of Lines 4, 9, 12, 13, 14, 19, 21, and 24): The total costs of decontaminating the sample incinerator are $63,044.

D. Monitoring

1. Cost of air sampling during inventory treatment: In order to ensure that the incinerator remains in compliance with Clean Air Act regulations during the closure period, it was assumed that daily sampling cost of $25 are incurred while the incinerator is operating.

2. Number of samples required: The inventory treatment phase of closure is estimated to take 16 days at the sample site.

3. Total costs of monitoring (Line 1 x Line 2): Given the above assumptions, monitoring costs will be equal to $400.

E. Professional Certification

1. Number of person-hours required for inspections: It is assumed that 20 hours are required for periodically inspecting all aspects of incinerator closure.

2. Cost per person-hour: In this case, assume that a registered independent professional engineer may be hired at a cost of $75 per hour.

3. Total costs of independent professional engineer's time (Line 1 x Line 2): This yields a total cost of $1500 for the independent professional engineer.

4. Number of technical hours required for administrative duties: Assume that eight hours are required from the owner's or operator's staff for administrative duties connected with employing an independent professional engineer.

5. Person-hour costs for technical administrative duties: It is assumed that the total fully-loaded costs for the owner's or operator's staff are $30 per hour.

6. Total administrative costs for technical labor (Line 4 x Line 5): Given the above assumptions, the total administrative costs for technical labor are $240.

7. Number of clerical hours required for administrative duties: Assume that five hours of clerical time are required for the necessary typing and certifications.

8. Person-hour costs for clerical administrative duties: Fully-loaded costs of clerical time are assumed to be $8.

9. Total administrative costs for clerical labor (Line 7 x Line 8): Given the above assumptions, total clerical costs are $40.

10. Total administrative costs (Line 6 + Line 9): Summing technical and clerical labor, the administrative costs are $280.

11. Total certification costs (Line 3 + Line 10): The total costs for certification, including engineer's fees and administrative costs, are $1780.

F. Total Costs Including Administration and Contingencies

Line 1 through 4: These lines simply require the transfer of the cost information supplied in Worksheets B through E.

5. Preliminary closure cost estimate (sum of Lines 1 through 4): For the sample facility, total worksheet costs are qual to $137,299.

6. Administration: The costs for administration, which include insurance, taxes, and supervision and administration not included elsewhere, are assumed to be 15 percent of Line 5.

7. Contingencies: A provision for contingencies of 15 percent of Line 5 has been included.

8. Total costs of closure (Line 5 + Line 6 + Line 7): The total costs of closure, including administration and contingencies, for the sample incinerator are $178,489.

INCINERATORS

WORKSHEET A - CHARACTERIZING THE WASTE (#2)

This worksheet should be used to describe each waste accepted at the facility.

1. Description of the waste:

   Phenolic wastewater

2. Chemical composition of the waste:

   1000 ppm phenols

3. Physical state of the waste:

   Liquid

4. Heat of combustion of the waste:

   0

5. Specific gravity of the waste:

   1.0

6. Closure inventory:

   40,320 gal.

INCINERATORS

WORKSHEET A - CHARACTERIZING THE WASTE (#3)

This worksheet should be used to describe each waste accepted at the facility.

1. **Description of the waste:**

    Waste activated sludge

2. **Chemical composition of the waste:**

3. **Physical state of the waste:**

    Mixture (suspension) - 10% solids, 90% water

4. **Heat of combustion of the waste:**

    700 BTU/lb.

5. **Specific gravity of the waste:**

    1.06

6. **Closure inventory:**

    241,920 gal.

INCINERATORS

WORKSHEET B - TREATING THE INVENTORY

1.	Time required for treating the inventory	373 hours
2.	Manpower requirements for treating the inventory	2238 man-hours
3.	Unit cost of labor	$20/hr.
4.	Total cost of labor - treating the inventory (Line 2 x Line 3)	$44,760
5.	Fuel requirements	Yes
6.	Electricity requirements	87,730 kwh
7.	Unit cost of electricity	$.06/kwh
8.	Total costs of electricity (Line 6 x Line 7)	$5264
9.	Auxiliary fuel requirements	Yes, for input feed B
10.	Type of fuel used	#6 fuel oil
11.	Quantity of fuel required	10,456 gal.
12.	Unit cost of fuel oil	$.90/gal.
13.	Total cost of auxiliary fuels (Line 11 x Line 12)	$9410
14.	Total fuel costs for treating inventory (Line 8 + Line 13)	$14,674
15.	Chemical requirements	Yes
16.	Type of chemicals used	Caustic, 50% solution
17.	Quantity of chemicals used	10,800 lbs.
18.	Unit cost of chemicals	$.0825/lb.
19.	Total cost of chemicals (Line 17 x Line 18)	$891
20.	Residues generated during inventory treatment	Incinerator ash
21.	Amount of residue generated	225,468 lbs. (196 drums)
22.	Method of treatment	Landfill
23.	Unit cost of disposing of residue	$50/drum
24.	Total costs of disposing of residue (Line 21 x Line 23)	$9800
25.	Hauling costs for disposing of residue	$1950
26.	Total costs of treating and disposing of inventory (sum of Lines 4, 14, 19, 24, and 25)	$72,075

INCINERATORS

WORKSHEET C - DECONTAMINATING THE FACILITY

1.	Volume to be cleaned	1,240,000 gal.
2.	Method used	Steam-cleaning
3.	Unit costs of cleaning	$.02/gal. capacity
4.	Total costs of tank cleaning (Line 1 x Line 2)	$24,800
5.	Cleaning residue generation rate	.125 x volume of tank
6.	Amount of residue generated (Line 1 x Line 5)	155,000 gal.
7.	Method of disposal	Surface impoundment
8.	Unit cost for disposing of residue	$.05/gal.
9.	Total costs for disposing of residue (Line 6 x Line 8)	$7750
10.	Unit cost for hauling residues	$300/trip
11.	Number of trips required	23
12.	Total costs of hauling residues (Line 10 x Line 11)	$6900
13.	Cost of flushing liquid waste feed lines	$3000
14.	Cost to pump out and backfill sumps	$2000
15.	Amount of contaminated soil area	1452 sq. yds.
16.	Depth of soil removal	1 ft.
17.	Total amount of soil removed (Line 15 x Line 18)	$774
18.	Unit cost of removing soil	$1.60/cu. yd.
19.	Total cost of removing soil (Line 17 x Line 18)	$774
20.	Costs for disposing of contaminated soils	$30/ton
21.	Total cost of disposing of soil (Line 17 x Line 20)	$14,520
22.	Unit costs of hauling contaminated soils	$150
23.	Number of trips required	22
24.	Total cost of hauling soils (Line 22 x Line 23)	$3300
25.	Total costs of decontamination (sum of Lines 4, 9, 12, 13, 14, 19, 21, and 24)	$63,044

INCINERATORS
WORKSHEET D - MONITORING

1.	Cost of air sampling	$25/day
2.	Number of samples required	16
3.	Total costs of air monitoring (Line 1 x Line 2)	$400

INCINERATORS

WORKSHEET E - PROFESSIONAL CERTIFICATION

1.	Number of person-hours required for inspecting the facility	20
2.	Cost per person-hour	$75
3.	Total costs of independent professional engineer certification (Line 1 x Line 2)	$1500
4.	Technical hours required for administrative duties	8 hrs.
5.	Person-hour costs for technical administrative duties	$30
6.	Total administrative costs for technical labor (Line 4 x Line 5)	$240
7.	Number of clerical hours required for administrative duties	5 hrs.
8.	Person-hour costs for clerical administrative duties	$8
9.	Total administrative costs for clerical labor (Line 7 x Line 8)	$40
10.	Total administrative costs (Line 6 + Line 9)	$280
11.	Total certification costs (Line 3 + Line 10)	$1780

INCINERATORS

WORKSHEET F - TOTAL COSTS INCLUDING ADMINISTRATION AND CERTIFICATION

1.	Costs of treating and disposing inventory (From Worksheet B)	$ 72,075
2.	Costs of decontaminating the facility (From Worksheet C)	$ 63,044
3.	Costs of monitoring (From Worksheet D)	$ 400
4.	Costs of professional certification (From Worksheet E)	$ 1,780
5.	Estimated basic costs of closure (sum of Lines 1, 2, 3, and 4)	$137,299
6.	Administration	$ 20,595
7.	Contingencies	$ 20,595
8.	Total costs of closure	$178,489

9.6 EXAMPLE - MULTIPLE PROCESS FACILITY WITH TANKS AND SURFACE IMPOUNDMENTS

A 2-acre hazardous waste treatment and storage facility has storage tanks for 60,000 gallons of waste solvents and 10,000 gallons of slop oil. Waste is received at the facility both from tank trucks and in 55 gallon drums; the facility has a maximum storage capacity of 200 drums. There are two treatment processes undertaken at the facility. There is a 30,000 gallon (50' x 20' x 4') concrete-lined surface impoundment used for the gravity separation of oily wastes into solvent, slop oil, and sludge phases. The normal composition of the oil wastes accepted is 80 percent solvent, 15 percent oil, and 5 percent sludge. There is a 30,000-gallon clay-lined surface impoundment (also 50' x 20' x 4') for solidifying pickling liquor wastes. A storage pile holds up to 8,000 cu. ft. of solidified pickling wastes; it is surrounded by a clay-lined surface impoundment that collects drainage and run-off.

SAMPLE CLOSURE COST ESTIMATING WORKSHEETS: MULTIPLE PROCESS FACILITY

A. Characterizing the Waste

Worksheet A is used to describe each waste accepted at the facility. For example, separate worksheets must be prepared for each of the following wastes: oily wastes and pickling liquor wastes (the two types of wastes processed at the storage facility) and the three end products of the treatment actions performed (waste organic solvents, slop oil, and solidified pickling liquor wastes). For each waste product specified, the following information is required:

1. Describing the waste: Describe the origin and general nature of the waste.

2. Chemical composition: Chemical composition should be expressed in weight percents for the various major components, and in parts per million (ppm) for any trace components. This information may be readily available to the operator from the bill of lading for each waste shipment.

3. Physical state: This describes whether the waste is a liquid, solid, or mixture. This information is used in making estimates of solid residues requiring disposal (Worksheet B).

4. Heat of combustion of the waste: Represents the heat content (expressed in BTU/lb. or BTU/gal.) of the waste products. The information is used to determine auxiliary fuel requirements if the waste is to be disposed of through incineration.

5. Specific gravity of the waste: The specific gravity of the waste at 60°F referenced to water at 60°F.

6. Closure inventory: The operator must identify the maximum quantity of each waste that can be present at the facility in storage tanks, drums, or surface impoundments, during any point in the facility's active life. In the example, it is assumed that there are times in which the storage capacity of this facility is completely utilized. This would therefore represent the maximum inventory for developing the closure cost estimate. In the sample case, the closure inventory would consist of 65,500 gallons of waste solvents, 10,000 gallons of slop oil, 35,000 gallons of oily waste, 30,000 gallons of pickling liquor waste and 8,000 cu. ft. of solidified pickling wastes.

B. Treating Inventory

1. Waste inventory: As noted in the waste characterization section of this example, the sample facility is assumed to have the following waste products on-site at the time of disposal: 35,500 gallons of oily waste, 30,000 gallons of pickling liquor wastes, 65,500 gallons of recovered waste solvent, 10,000 gallons of recovered slop oils, and 8,000 cu. ft. of solidified pickling wastes.

2. Methods of treatment or removal: These materials will be removed of in a variety of ways, as indicated below:

a. Solvents - it is assumed that the facility can find other manufacturing/commercial establishments that will use the waste solvents (which have a BTU content of 135,000 BTU/gal.) as boiler fuel.

b. Slop Oils - pumped out of storage and hauled to an incinerator.

c. Oily Wastes - placed in surface impoundment for separation into its component parts. Solvents and slop oils recovered from this process are disposed of in the same manner as (a) and (b) above. Sludges left in the basin are to be dredged, stabilized and hauled to a landfill.

d. Pickling Liquor Wastes - solidify with cement and transfer the resulting solid waste to a landfill.

e. Solidified Pickling Liquor Wastes - transfer to a landfill.

Since treatment of inventory categories (c) and (d) will generate additional waste products in categories (a), (b) and (e), these preliminary processing phases will be discussed first.

Disposing of Oily Waste

3. Composition of oily wastes: It is assumed that the normal composition of the oily wastes is 80 percent solvent, 15 percent slop oil, and 5 percent sludge.

4. Amount of wastes produced after settling: Using this percentage mix, settling out the inventory of oily wastes will produce 28,400 gallons of solvent, 5,325 gallons of slop oil, and 1,775 gallons of sludge.

5. Sorbent requirements: It is assumed that the sludge will be mixed with an equal volume of sorbent material, with a specific gravity of 1.8. The specific gravity of the sludge is estimated at 1.2.

6. Cost of sorbent: It is assumed that sorbent material is available on-site for no cost.

7. Amount of residue generated: After stabilization, approximately 22 tons of residue will need to be landfilled.

8. Unit cost of disposing of residue: It is assumed that a landfill will charge $50/ton to dispose of the stabilized residues.

9. Total costs of disposing of residue (Line 7 x Line 8): Given these assumptions, the total cost of disposing of facility sludge residues will be $1100.

10. Costs of hauling residue: It is assumed that the nearest landfill is 100 miles one-way from the site. Trucks with a 44,000-lb. capacity can be rented at a cost of $60 per hour (including driver); the average traveling speed of the truck is 40 mph. For one round trip, the cost of residue hauling is $300.

11. Number of hauls required: With 22 tons of waste (line 7), only one trip by a 44,000 lb. capacity truck will be required.

12. Total cost of hauling residue (Line 10 x Line 11): Given these assumptions, the total cost of hauling residue is $300.

13. Cost of disposing of oily waste (Line 6 + Line 9 + Line 12): The total cost of disposing of oily waste is then the sum of sorbent material costs, costs of disposal, and costs of hauling for a total of $1400.

Disposing of Pickling Liquor Waste

14. In order to solidify the pickling liquor wastes in the closure inventory, the waste must be mixed with cement. It is estimated that one sack (94 lbs/sack) of cement will solidify 10 gallons of waste.

15. Amount of cement required: To dispose of on-site inventory, 3,000 sacks of cement (282,000 lbs.) will be required.

16. Cost of cement: Cement is estimated to cost $2.50/sack.

17. Total cost of materials (Line 15 x Line 16): Given the above assumptions, total material costs for solidifying the inventoried pickling liquor waste are $7,500.

18. Total amount of residues produced: Given a specific gravity of pickling wastes of 1.05, and the proportions of cement to waste assumed, the total solid residues produced by inventory disposed is 272.4 tons.

Liquor = 30,000 gal x 1.05 S.G. x 8.34 (water weight) = 262,800 lb.

Cement = 3,000 sacks x 94 lbs/sack = 282,000 lbs.

262,000 lbs + 282,000 lbs = 544,800 lbs = 272.4 tons

19. Other on-site residues: Waste category (e) represents-- previously solidified pickling wastes stored on-site. It is assumed that there is 8,000 cu. ft. of this material currently in storage, and that the material weighs approximately 135 lb/cu. ft (similar to a mortar-like cement). Therefore, the total weight of this residue would be 1,080,000 lbs. (540 tons).

20. Total amount of pickling residue (Line 18 + Line 19): Total solid residues from treatment of the pickling wastes are 812.4 tons.

21. Unit cost of disposing of residue: As in Line 8 above, it is assumed that a landfill will charge $50/ton to dispose of such residues.

22. Total cost of disposing of residue (Line 20 x Line 21): Total disposal costs are estimated to be $40,620.

23. Costs of hauling residues: The costs and method of hauling residues are the same as Line 10 above.

24. Number of hauls required: Given truck capacity of 44,000 lbs. (22 tons), it will take 37 round trips to haul the solidified pickling wastes.

25. Total cost of hauling residues: Given the above assumptions, the total hauling costs will be $11,100.

26. Cost of disposing of pickling liquor waste (Line 17 + Line 22 + Line 25): The total cost of disposing of pickling liquor waste is then the sum of costs of materials, residue disposal and hauling, for a total of $59,220.

27. Amount of solvent on-site: Including the solvents recovered during the settling of inventoried oily waste, the total inventory of waste solvents at the sample facility are 60,000 gal. (storage tank) + 5,500 gal. (drums) + 28,400 gal. (surface impoundment) = 93,900 gal.

28. Method of disposal: It is assumed that the waste solvents can be provided to manufacturers as a boiler fuel.

29. Cost of disposal: It is assumed that the users of the solvents will pay the costs of pumping and hauling the solvents to their facilities. No additional credit is awarded to the owner/operator of the tank facility.

Treating Slop Oil

30. Amount of slop oil on-site: Including the slop oils recovered during the settling of inventoried oily waste, the total inventory of slop oils are 10,000 gal. (storage tank) + 5,325 gal. (surface impoundment) = 15,325 gal.

31. Method of treatment: It is assumed that the slop oils will be trucked to an incinerator.

32. Cost of treatment: The estimated fee paid to the incinerator for treating the wastes is $0.60/gallon.

33. Total costs of treatment (Line 30 x Line 32): Given the above assumptions, it will cost $9,195 to treat the slop oil inventory.

34. Costs of hauling: It is assumed that the nearest incinerator is 50 miles away, that the wastes will be transported in a 7,000-gallon capacity truck, at an average speed of 40 mph. The hourly rental cost for truck and driver is $60.

35. Number of hauls required: Given trailer capacity, it will require three trips to haul the slop oils to the incinerators.

36. Total costs of hauling: Given the above assumptions, hauling costs are estimated at $450.

37. Total costs of treating slop oil (Line 33 + Line 36): The total costs of treating slop oil are then the sum of the costs of disposal and hauling, for a total of $9,645.

38. Total costs of disposing of inventory (sum of Lines 6, 9, 12, 17, 22, 25, 29, 33, and 36): The total costs of the above activities are estimated to be $70,265.

C. Decontaminating the Facility

Tank Cleaning

1. Cleaning method: In this example, the storage tanks are steam cleaned.

2. Volume: In the sample case, there are 60,000 gallons of solvent storage capacity and 10,000 gallons of oil storage capacity to be cleaned, for a total of 70,000 gallons.

3. Unit cleaning costs: For a 2,000 gallon-per-hour steam cleaning unit (capable of washing a 16,000-gallon area of storage capacity/hour), costs of equipment rental, labor, and operation are equal to $.02/gallon of capacity cleaned.

4. Total costs of steam cleaning (Line 2 x Line 3): Total cleaning costs for the storage tanks is $1400.

5. Type and quantity of residues generated: Steam cleaning generates residues in the form of contaminated washwaters. The rate of residue generation is 1 gallon of waste/8 gallons of tank volume. In the example, total residues are 70,000 ÷ 8, or 8750 gal.

6. Method of disposal: It is assumed that the residues are hauled to a surface impoundment and evaporated.

7. Cost of disposal: Impoundment disposal of washwaters is estimated to cost $.05/gallon.

8. Total cost of disposal (Line 5 x Line 7): Costs of disposing of these cleaning residues will be $438.

9. Cost of hauling cleaning residues: For one round trip, the cost of hauling residues is $600. The cleaning residues will be hauled in a 7,000-gallon tank truck, with an average truck speed of 40 mph. The hourly rental cost for truck and driver is $60; the nearest available surface impoundment is assumed to be 200 miles away.

10. Number of hauls required: Given the assumption on residue generation and truck capacity, two trips will be required, at $600/trip.

11. Total costs of hauling: Total hauling costs are $1200.

12. Total costs: The sum of the costs of steam cleaning, disposal and hauling yields a total of $3038.

Decontaminating the Impoundment

13. Cleaning method for Impoundment 1: It is assumed that the concrete-lined impoundment will be sandblasted.

14. Area of concrete impoundment to be cleaned: The area requiring sandblasting, based on the sample facility description, is equal to the base area (50' x 20', or 100 sq. ft.) plus the area of the site walls (2' x 50' x 4' + 2' x 20' x 4', or 560 sq. ft.), for a total of 1560 sq. ft.

15. Costs of sandblasting: A 6 cu. ft. capacity compressor will be used in the sample estimate. The unit rents for a $100/week, and costs $1.75/hour to operate; labor costs are estimated at $20/hour. The unit can clean 40 sq. ft. of concrete/hour. Consequently, sandblasting costs are estimated at $.60/sq. ft.

16. Total costs of sandblasting (Line 14 x Line 15): Sandblasting costs are estimated to be $936.

17. Type and quantity of residue generated: The residues will consist of contaminated sands. It was assumed that 4000 lbs. (2 tons) of sand residue will be generated.

18. Unit costs of disposal: The sands will be landfilled at a disposal cost of $50/ton.

19. Total costs of disposal (Line 17 x Line 18): Total disposal costs will be equal to $100.

20. Cleaning method for Impoundment 2: All contaminated clays from the clay-lined impoundment will be removed and hauled to a landfill.

21. Area of clay impoundment to be decontaminated: Since the dimensions of this impoundment are the same as those of the concrete-lined impoundment discussed above, the surface area to be contaminated is the same as that estimated in Line 14 of this worksheet, or 1560 sq. ft.

22. Amount of clay removed: It is assumed that the clay in the pickling liquor impoundment has been contaminated to a depth of one foot. Therefore, 1560 cu. ft. of clay, or 57.8 cu. yds., must be removed.

23. Unit cost of removing clay: Clay removal will be performed with a backhoe. Including costs of equipment rental and labor, the costs of removing the clay is estimated to be $1.60/cu. yd.

24. Total costs of removing clay (Line 22 x Line 23): Given the above assumptions, the costs of removing the soil are $92.

25. Disposing of contaminated clays: Clays will be hauled to a landfill for disposal. The costs of disposal are estimated to be $30/cu. yd.

26. Total costs of disposal (Line 22 x Line 25): The total costs of disposal are $1734.

Removing Soil and Miscellaneous Activities

27. Removing contaminated soils: Because of spills and other accidental releases, certain areas of the waste disposal facility, such as diked-in areas around storage tanks will be contaminated. It is assumed for the sample facility that 2.5 percent of the total site area is contaminated.

Contaminated area = 2 acres x 4840 sq. yd./acre x .025 rate of contamination - 242 sq. yd.

28. Amount of soil removed: The depth of soil removal required to remove all hazardous contaminants is assumed to be 1 foot. Thus, the total amount of soil removed - 242 sq. yd. x .33 yd. = 80.7 cu. yds.

29. Unit cost of removing soil: As in Line 23, removing soil can be accomplished at a cost of $1.60/cu. yd.

30. Total cost of removing soil (Line 28 x Line 29): Total cost of removing soil is $129.

31. Disposing of contaminated soils: Contaminated soils are also hauled to a landfill, where they may be disposed at a cost of $30/cu. yd.

32. Total costs of disposal (Line 28 x Line 31): Given the above assumptions, disposing of soils will cost $2421.

33. Hauling costs for decontamination wastes: The wastes described in Lines 17, 22, and 28 of this Worksheet will be hauled to the landfill in a 44,000-lb. truck. The landfill is assumed to be 100 miles away; the hourly cost of truck and driver is $60 and the average trip speed is 40 mph. Adequate dividers will be supplied so that mixed loads can be carried.

34. Number of trips required: If it is assumed that a cu. yd. of earth weighs approximately 2000 lbs., the hauling of these waste residues will require seven trips.

35. Costs of hauling decontamination residues (Line 33 x Line 34): At $300 per round trip, total hauling costs would be $2100.

36. Flush pumps and transfer lines: All pumps and piping used to transfer hazardous waste are flushed to remove contaminants. This process is assumed to cost $2000.

37. Decontaminate equipment: All materials handling equipment used on-site must be decontaminated. This is assumed to cost $500.

38. Decontaminate containers: In the example, it is assumed that all drums kept on-site will be crushed and buried in a landfill, at a total cost of $1000.

39. Total costs of decontaminating facility (sum of Lines 4, 8, 11, 16, 19, 24, 26, 30, 32, 35-38): Total costs of decontaminating the facility, based on the above assumptions, are estimated to be $14,070.

D. Professional Certification

1. Number of person-hours required for inspections: It is assumed that 16 hours are required for periodically inspecting all aspects of closing the tanks and impoundments.

2. Cost per person-hour: In this case, assume that a registered independent professional engineer may be hired at a cost of $75 per hour.

3. Total costs of independent professional engineer's time (Line 1 x Line 2): This yields a total cost of $1200 for the independent professional engineer.

4. Number of technical hours required for administrative duties: Assume that 8 hours are required from the owner's or operator's staff for administrative duties connected with employing an independent professional engineer.

5. Person-hour costs for technical administrative duties: It is assumed that the total fully-loaded costs for the owner's or operator's staff are $30 per hour.

6. Total administrative costs for technical labor (Line 4 x Line 5): Given the above assumptions, the total administrative costs for technical labor are $240.

7. Number of clerical hours required for administrative duties: Assume that 5 hours of clerical time are required for the necessary typing and certifications.

8. Person-hour costs for clerical administrative duties: Fully-loaded costs of clerical time are assumed to be $8 per hour.

9. Total administrative costs for clerical labor (Line 7 x Line 8): Given the above assumptions, total clerical costs are $40.

10. Total administrative costs (Line 6 + Line 9): Summing technical and clerical labor, the administrative costs are $280.

11. Total certification costs (Line 3 + Line 10): The total costs for certification, including engineer's fees and administrative costs, are $1480.

E. Total Costs Including Administration and Contingencies

Items 1 through 3 give the costs of all activities on each of the preceding worksheets. Line 4 is the total of Lines 1 through 3, $85,815.

5. Contingencies: A general provision for contingencies of 15 percent of Line 4 has been included.

6. Administrative and supervisory cost: For administrative tasks, including taxes, insurance, and administration and supervision not included elsewhere, a total of 15 percent of total costs from Line 4 is used.

7. Total costs of closure (Line 4 + Line 5 + Line 6): The total costs for closing the tanks and impoundments are estimated for the sample case to be $111,559.

MULTIPLE PROCESS FACILITY

WORKSHEET A - CHARACTERIZING THE WASTE (#1)

1. **Description of the waste**

   Organic solvent
2. **Chemical composition**

   (Not given)
3. **Physical state of the waste**

   Liquid
4. **Heat of combustion of the waste**

   18,000 BTU/lb.(135,000 BTU/gal.)
5. **Specific gravity of the waste**

   .9
6. **Maximum inventory of the waste**

   60,000 gallons bulk storage

   5,500 gallons in drums
7. **ID numbers for areas holding these wastes**

   Tanks T-1 to T-4

MULTIPLE PROCESS FACILITY

WORKSHEET A - CHARACTERIZING THE WASTE (#2)

1. Description of the waste

   Slop oil

2. Chemical composition

   (Not given)

3. Physical state of the waste

   Liquid

4. Heat of combustion of the waste

   16,000 BTU/lb.(126,720 BTU/gal.)

5. Specific gravity of the waste

   .95

6. Maximum inventory of the waste

   10,000 gallons bulk storage

7. ID numbers for areas holding these wastes

   Tank T-5

MULTIPLE PROCESS FACILITY
WORKSHEET A - CHARACTERIZING THE WASTE (#3)

1. Description of the waste

   Oily wastes

2. Chemical composition

   (Not given)

3. Physical state of the waste

   Mixture (95% liquids, 5% sludge)

4. Heat of combustion of the waste

   (Not given)

5. Specific gravity of the waste

   (Not given)

Maximum inventory of the waste

   30,000 gallons in holding basin

   5,500 gallons in drums

7. ID numbers for areas holding these wastes

   Impoundment S-1

MULTIPLE PROCESS FACILITY

WORKSHEET A - CHARACTERIZING THE WASTE (#4)

1. Description of the waste

    Pickling liquor waste

2. Chemical composition

    (Not given)

3. Physical state of the waste

    Liquid

4. Heat of combustion of the waste

    0

5. Specific gravity of the waste

    1.05

6. Maximum inventory of the waste

    30,000 gallons in holding basin

7. ID numbers for areas holding these wastes

    Impoundment B-1

MULTIPLE PROCESS FACILITY

WORKSHEET A - CHARACTERIZING THE WASTE (#5)

1. Description of the waste

    Solidified pickling liquor wastes

2. Chemical composition

    (Not given)

3. Physical state of the waste

    Solid

4. Heat of combustion of the waste

    (Not given)

5. Specific gravity of the waste

    2.2

6. Maximum inventory of the waste

    8,000 cu. ft. in storage pile

7. ID numbers for areas holding these wastes

    None

MULTIPLE PROCESS FACILITY

WORKSHEET B - TREATING THE INVENTORY

1. Waste inventory at time of closure

Waste solvents	65,500 gal.
Slop oil	10,000 gal.
Oily wastes	35,500 gal.
Pickling liquor wastes	30,000 gal.
Solidifed pickling wastes	8,000 cu. ft.

2. Methods of treatment or removal

Waste solvents	Reuse as boiler fuel
Slop oil	Incinerate
Oily wastes	Separate; recover solvents, incinerate slop oils, landfill sludges
Pickling liquor wastes	Solidify, landfill
Solidified pickling wastes	Landfill

Disposing of Oily Waste

3.	Composition of waste 80% solvent, 15% slop oil, 5% sludge	
4.	Amount of waste produced 28,400 gal. solvent, 5,325 gal. slop oil,	1,775 gal. sludge
5.	Amount of sorbent used in sludge treatment	1:1 ratio with oils
6.	Cost of sorbent used	0
	a. Cost of materials	0
7.	Amount of residue generated	22 tons
8.	Unit cost of disposing or removing residue	$50/ton
9.	Total cost of disposing or removing residue (Line 7 x Line 8)	$1100
10.	Costs of hauling residue	$300/trip
11.	Number of trips required	1
12.	Total cost of hauling residue (Line 7 x Line 10)	$300
13.	Costs of disposing or removing oily waste (Line 6 + Line 9 + Line 11)	$1400

WORKSHEET B (continued)

Treating or Removing Pickling Liquor Waste

14.	Amount of cement required for solidification	1 sack/10 gal.
15.	Total amount of cement required	3000 sacks
16.	Cost of cement	$2.50/sack
17.	Cost of materials (Line 15 x Line 16)	$7,500
18.	Amount of residues produced by treating inventory	272.4 tons
19.	Amount of other residues already on-site	540 tons
20.	Total amount of pickling residues (Line 18 + Line 19)	812.4 tons
21.	Unit cost of disposing or removing residue	$50/ton
22.	Total cost of disposing or removing residue (Line 20 x Line 21)	$40,620
23.	Costs of hauling residues	$300/trip
24.	Number of trips required	37
25.	Total costs of hauling (Line 23 x Line 24)	$11,100
26.	Costs of disposing or removing pickling liquor waste (Line 17 + Line 22 + Line 25)	$59,220

Removing Waste Solvent

27.	Amount of waste solvent	93,900 gal.
	a. Amount of solvent in inventory	65,500 gal.
	b. Amount of solvent obtained from oily waste inventory treatment	28,400 gal.
28.	Method of removal	Recovery and reuse as boiler fuel
29.	Cost of removal	0

Treating Slop Oil

30.	Amount of slop oil on-site	15,325 gal.
	a. Amount in inventory	10,000 gal.
	b. Amount generated from disposing or treating oil waste inventory	5,325 gal.
31.	Method of treatment	Incinerate
32.	Unit cost of treatment	$0.60/gal.
33.	Total cost of treatment (Line 30 x Line 32)	$9,195
34.	Unit costs of hauling residues	$150/trip

WORKSHEET B (continued)

35.	Number of trips required	3
36.	Total costs of hauling (Line 34 x Line 35)	$450
37.	Costs of treating slop oil	$9,645
38.	Total costs of treating inventory (Sum of Lines 6, 9, 12, 17, 22, 25, 29, 33 and 36)	$70,265

MULTIPLE PROCESS FACILITY

WORKSHEET C - DECONTAMINATING THE FACILITY

Tank Cleaning

1.	Cleaning method used	Steam cleaning
2.	Capacity to be cleaned	70,000 gallons
3.	Unit cleaning costs	$.02/gallon
4.	Total costs of steam cleaning (Line 2 x Line 3)	$1,400
5.	Quantity and type of residues generated	8,750 gallons of contaminated washwaters
6.	Method of disposal	Surface impoundment
7.	Cost of disposal	$.05/gallon
8.	Total cost of disposal (Line 5 x Line 7)	$438
9.	Cost of hauling residues	$600/trip
10.	Number of trips required	2
11.	Total costs of hauling (Line 9 x Line 10)	$1200
12.	Total costs of tank cleaning	$3038

Decontaminating the Impoundment

13.	Cleaning method used - Surface Impoundment 1	Sandblasting
14.	Area to be cleaned	1560 sq. ft.
15.	Unit costs of sandblasting	$.60/sq. ft.
16.	Total costs of sandblasting (Line 14 x Line 15)	$936
17.	Quantity of residues generated	2 tons of contaminated sand
18.	Unit costs of disposing of residue	$50/ton
19.	Total costs of disposing of residue (Line 17 x Line 18)	$100
20.	Cleaning method used - Surface Impoundment 2	Clay removal and landfill disposal
21.	Area to be cleaned	1560 sq. ft.
22.	Amount of clay removed	57.8 cu. yds.
23.	Unit cost of removing clay	$1.60/cu. yd.
24.	Total cost of removing clay (Line 22 x Line 23)	$92

WORKSHEET C (continued)

25.	Unit cost of disposing of residue (clay)	$30/cu. yd.
26.	Total costs of disposal (Line 22 x Line 25)	$1734

Soil Removal and Miscellaneous Site Cleanup

27.	Soil area contaminated	2.5% of site area (242 sq. yd.)
28.	Amount of soil removed	80.7 cu. yd.
29.	Unit cost of removing soil	$1.60/cu. yd.
30.	Total cost of removing soil (Line 28 x Line 29)	$129
31.	Unit costs of contaminated soil disposal	$30/cu. yd.
32.	Total costs of disposing of soil (Line 28 x Line 31)	$2421
33.	Hauling costs for decontamination wastes (including impoundment cleanup)	$300/trip
34.	Number of trips required	7
35.	Total costs of hauling	$2100
36.	Costs of flushing pump and transfer lines	$2000
37.	Decontaminate equipment	$500
38.	Decontaminate containers	$1000
39.	Total costs of decontaminating the facility	$14,070

MULTIPLE PROCESS FACILITY

WORKSHEET D - PROFESSIONAL CERTIFICATION

1.	Number of person hours required for inspections	16 hours
2.	Cost per person-hour: engineer	$75
3.	Total costs of independent professional engineer's time (Line 1 x Line 2)	$1200
4.	Number of technical hours required for administration	8 hours
5.	Cost per person-hour: technical	$30
6.	Total administrative costs for technical labor (Line 4 x Line 5)	$240
7.	Number of clerical hours required for administration	5 hours
8.	Costs per person-hour: clerical	$8
9.	Total administrative costs for clerical labor (Line 7 x Line 8)	$40
10.	Total administrative costs (Line 6 + Line 9)	$280
11.	Total certification costs (Line 3 + Line 10)	$1480

MULTIPLE PROCESS FACILITY

WORKSHEET E - TOTAL COSTS INCLUDING ADMINISTRATION AND CONTINGENCIES

1.	Costs of disposing of inventory (From Worksheet B)	$ 70,265
2.	Costs of decontaminating the facility (From Worksheet C)	$ 14,070
3.	Costs of professional certification (From Worksheet D)	$ 1,480
4.	Subtotal	$ 85,815
5.	Contingencies	$ 12,872
6.	Administration	$ 12,872
7.	Total closure costs (Line 4 + Line 5 + Line 6)	$111,559

9.7 EXAMPLE - POST-CLOSURE COST ESTIMATES

A large flat landfill of 200 acres has been closed in accordance with the EPA interim status regulations. This landfill consists of rather closely spaced narrow trenches that are protected by clay covers and cover vegetation. The facility soil is a soil which is mostly clay in content. All of the facility is planted with grass to resist erosion.

The post-closure operations at this facility have been planned to carry out the requirements of the interim status regulations. The activities planned are as follows:

- periodically inspecting the facility
- mowing
- routine erosion repairs
- replacing security fences (as needed)
- fertilizing
- leachate pumping and disposal
- ground-water monitoring
- monitoring well replacement (as needed)
- repair of severe erosion caused by storms
- post-closure administrative services

These activities are costed in the attached annotated worksheets. All of these activities are costed based on the assumption that the facility is completely closed and that no "free" assistance is available from an active portion of the facility. This means that some of the supporting facilities such as office space that are available during closure are not automatically available during the post-closure period.

SAMPLE POST-CLOSURE COST ESTIMATING WORKSHEETS

A. Periodically Inspecting the Facility

1. Number of technical management person-hours required for each inspection: Each inspection at this closed hazardous waste facility will be conducted by two people in a rented vehicle. We are of the opinion that two people are needed to conduct the inspection of the large closed waste disposal area (200 acres) and that an extra measure of safety is afforded by having two inspectors. Each inspection takes a full day of work by two technically trained managers.

2. Annual number of routine inspections: Six routine inspections will be conducted during each year of the post-closure period. These will be conducted on a bimonthly basis.

3. Person-hour costs for technical management labor: The fully-loaded labor rate for this technically trained labor is $30 per hour.

4. Technical labor costs for annual routine inspections (Line 1 x Line 2 x Line 3): The technical labor cost for these annual routine inspections is the product of the person-hours required for each inspection, the number of inspections planned, and the technical labor rate.

5. Annual number of engineer-supported inspections: In addition to the routine inspections described above, two annual engineer-supported inspections are planned. These inspections use a team of professional engineers and one of our technical managers. The engineer is a state-certified professional engineer from an independent firm that is contracted to supply professional services to the hazardous waste disposal facility.

6. Number of independent state-certified engineering hours for each engineer-supported inspection: For each inspection, eight hours of the engineer's time is required.

7. Number of technical management hours for each engineer-supported inspection: For each inspection, eight hours of technical labor is required. This requirement is in addition to the engineering labor that is required.

8. Person-hour cost for a professional engineer: The quoted cost of engineering services is $75 per hour. These services will be obtained from an independent engineering firm.

9. Engineering labor costs for the engineer-supported inspections (Line 5 x Line 6 x Line 8): The cost of the engineering labor is the product of the number of engineer-supported inspections, the number of engineering hours needed for each inspection, and the person-hour cost of engineering services.

10. Technical labor costs for the engineer-supported inspections (Line 3 x Line 5 x Line 7): The technical managerial labor costs for the engineer-supported inspections is the product of the labor rate for technical labor, the number of inspections required, and the technical labor hours required for each inspection.

11. Labor costs for the engineer-supported inspections (Line 9 + Line 10): The total labor costs for the engineer-supported inspections is the sum of the engineering labor and technical labor costs.

12. Cost of renting the truck for each inspection: A rented pick-up truck is used for transporting the inspectors throughout the hazardous waste disposal facility. The quoted rate for the truck is $25 per day and $.14 per mile. In addition, the renter must supply gasoline. The mileage for each inspection is 50 miles including the trips between the facility and the rental agency. This results in a total cost for the truck of $36 per day ($25 rental, $7 mileage, and $4 gasoline). The gasoline value is estimated based on a truck mileage of 15 mpg and a gasoline price of $1.20 per gallon.

13. Annual cost of renting the truck for inspections (Line 2 + Line 5 x Line 12): The total annual truck rental cost is the product of the total number of inspections needed (both routine and engineer-supported) and the daily truck rental cost.

14. Total annual inspection cost (Line 4 + Line 11 + Line 13): The total cost of conducting this post-closure inspection program is the sum of the annual total labor costs for the routine inspections, the annual labor costs for the engineer-supported inspections, and the annual rental costs for the truck.

B. Routine Monitoring and Maintenance Activities

Mowing Operations

1. Facility acreage: The waste disposal area of this hazardous waste facility is 200 acres. This area includes the cover of the waste disposal trenches and land close to the trenches.

2. Mowing labor: The waste disposal area is to be mowed periodically to promote the growth of cover vegetation and to inhibit the growth of large deep-rooted vegetation such as young trees. This mowing is to be carried out on a contract basis by a mowing service. The quoted labor rate for this service is $14.28 per acre mowed.

3. Mowing equipment: The quoted rate for the mowing equipment is $5.37 per acre mowed. This rate includes fuel and all equipment costs.

4. Unit mowing cost (Line 2 + Line 3): Adding the labor rate and the equipment rate yields the total contracted mowing rate (unit cost) for each acre mowed. Cheaper agricultural methods cannot be used because of the impact of the heavier equipment on the cover.

5. Annual frequency of mowing: Mowing of the waste disposal area is required once a year during the post-closure period. This frequency of mowing will encourage the growth of cover vegetation and will suppress the growth of trees and other deep-rooted vegetation.

6. Annual cost of mowing (Line 1 x Line 4 x Line 5): The annual cost of mowing is the product of the facility acreage, the unit mowing cost, and the annual frequency of mowing.

Routine Erosion Damage Repair

7. Annual routine erosion rate: The annual routine loss of soil from the facility is computed using the Universal Soil Loss Equation (USLE).

$$A = RKLSCP$$

A = Average soil loss, tons/acre
R = Rainfall and run-off erosivity index
K = Soil erodibility factor
L = Slope - length factor
S = Slope - steepness factor
C = Cover/management factor (type of vegetative cover)

P = Practice factor (terracing, contour plowing)

This equation computed for the sample facility's location yields an annual soil loss of 0.12 tons per acre. With a soil density of approximately 100 lbs. per cu. ft., 0.089 cu. yds. are lost from each acre. In our subsequent computations, we make the very conservative assumption that all of the lost soil will have to be replaced and reseeded.

8. Total annual routine erosive loss (Line 1 x Line 7): The total annual routine soil loss is the product of the acreage times the annual soil loss per acre.

9. Unit cost for land excavation of soil: Replacement soil will be obtained on-site at the facility. Since the amount of soil required is very small compared to the daily capacity of earth-moving machinery, hand labor will be used to excavate the soil. The rate stated here is a fully-loaded rate for union labor working for an independent contractor. This unit cost is based on contractor quotes.

10. Unit cost for on-site transportation of soil: The excavated soil is transported by truck on-site to the location where the erosion repair is to be made. This service will be provided by an independent contractor.

11. Unit cost for compacting the soil by hand: The unit cost of hand compacting the new soil as a repair for erosion damage is estimated to be the same as for hand excavation of the soil. This service will be provided by an independent contractor.

12. Unit cost of seeding: The cost of seeding is a function of the surface area of the new bare soil. In our estimates, we assume that a small gully (or gullies) have formed. The ratio of surface area to soil volume is small. This new soil is seeded with the same type of grass as is used for the original cover vegetation.

13. Aggregate unit cost of repairing routine soil erosion damage (Line 9 + Line 10 + Line 11 + Line 12): The aggregate unit cost of repairing the routine soil erosion is the sum of the excavation unit cost, the on-site trucking, the hand compacting of the soil, and hand seeding of the bare soil.

14. Total annual cost for repairing erosive damage of a routine nature (Line 8 x Line 13): The total annual cost of such routine erosive

repairs under average rainfall conditions is the product of the amount of soil lost and the unit aggregate cost for erosion damage repairs.

15. Adjustment factor to account for unusually wet seasons: The above cost (Line 14) is computed for average rainfall conditions at the facility location. A safety factor of 2 is applied which is the equivalent of increasing the rainfall and runoff erosivity index (within the Universal Soil Loss Equation) from 150 to 300. This changes the facility's rainfall from its actual mid-Atlantic level to the high southern levels. This conservative assumption is required to allow for the annual variation in routine rainfall-caused erosion.

16. Adjusted annual cost for repairing routine erosion damage (Line 14 x Line 15): The adjusted annual cost for erosion repair of a routine nature is the product of the average annual cost and the adjustment factor.

Replacing the Fence

17. Frequency of replacing the fence: Security at the facility is provided by a 6-ft. high chain link fence that has been established along the entire perimeter of the facility (11,808 ft. in length). This fence is made of galvanized #9 wire. Operating experience at this hazardous waste facility indicates that the fence must be replaced every 15 years. Thus, during the anticipated 30-year duration of the closure period, the fence will have to be replaced once.

18. Facility perimeter: The length of the security fence is the length of the facility perimeter (11,808 ft.).

19. Unit cost of replacing the fence: Quotes were obtained from fencing suppliers for a new fence of equal specifications. The value given here is a unit cost per linear foot for an installed fence.

20. Total cost of fence replacement (Line 18 x Line 19): The cost of replacing the perimeter security fence is the product of the perimeter footage and the unit cost of the installed fencing.

21. Pro-rated annual cost of fence replacement: The total cost of replacing the security fence is pro-rated to each year by dividing the total cost (Line 20) by the number of years in the post-closure period (30 years).

Fertilizing

22. Unit cost of fertilizing: The hazardous waste disposal facility has relatively poor soil resulting in the experienced necessity of annual fertilizer applications until the vegetation has become established, & periodic applications thereafter. Type 10/6/4 fertilizer costing $0.12 per lb. (in 50-lb. bags) is applied at a rate of 500 lbs. per acre. This corresponds to a nitrogen application rate of 50 lbs. per acre. The unit cost of fertilization is the sume of the labor, materials and equipment costs.

Labor	$69.10/acre
Materials	$60.00/acre
Equipment	$ 5.00/acre

Previous experience at this facility has shown that this application rate for fertilizer is satisfactory to maintain the vegetation.

23. Number of applications of fertilizer for the first 3 years: One application of fertilizer is needed each year for a total of 3 applications.

24. Number of applications of fertilizer for remaining years of post-closure (Years 4 through 30): One application of fertilizer is needed every 5 years, or a total of 5 applications for the remainder of post-closure.

25. Total costs of fertilizing for the first 3 years of post-closure (Line 1 x Line 22 x Line 23): The cost of fertilizing for the first 3 years is the product of the acreage fertilized, the unit cost of fertilization and the frequency of application during the first 3 years. The costs of fertilizing for the first 3 years are then $80,460.

26. Total costs of fertilization for years 4 through 30 of post-closure (Line 1 x Line 22 x Line 24): The cost of fertilizing is the product of the acreage fertilized, the unit cost of fertilizing, and the frequency of application during the years 4 through 30. The costs for fertilizing for the remainder of post-closure is then $134,100.

27. Total costs of fertilizing during post-closure (Line 25 + Line 26): The total fertilization costs are the sum of the costs for fertilizing during the first 3 years and the 5 applications required during the remainder of post-closure. The total costs for fertilizing for the entire 30-year period are then $214,560.

28. Total annual costs of fertilizing (Line 27 ÷ 30): The total costs for fertilizing for the 30-year period is divided by the

30 years of the post-closure period to yield an annual cost of $7152.

Ground-Water Monitoring Well Replacement

29. Unit cost for well replacement: The lowest observed depth of the water table has been closer to the surface than 50 ft. throughout the active operation of the facility. A replacement well to a depth of aprpoximately 50 ft. will cost $425 when installed by an independent contractor ($8.50 per vertical linear ft.). This quoted price includes a suitable casing.

30. Number of wells needing replacement: The monitoring wells have a relatively long useful lifetime as do residential wells. It is anticipated that two wells will have to be replaced during the post-closure period.

31. Total cost of monitoring well replacement (Line 29 x Line 30): The total post-closure period cost of well replacement is the unit cost of each well multiplied by the number of wells required in the post-closure period.

Leachate Pumping and Disposal

32. Frequency of removing the leachate: Leachate is removed periodically from the hazardous waste facility risers by means of a vacuum truck. Every month, the truck circulates to each riser pumping out the collected leachate. This service is performed by an independent contractor.

33. Average total monthly leachate withdrawal: Since the facility's cover system is quite effective in reducing infiltration, only 2000 gals. of leachate (average value) will have to be removed each month. This leachate is removed to an off-site disposal area.

34. Unit cost of removing the leachate to an active off-site disposal area: The unit cost of removing the leachate includes driving the vacuum truck to each riser at the facility and removing the leachate and delivering the truckload of leachate to the off-site disposal area. A relatively high per-gallon removal cost is quoted because of the necessity of collecting a small amount of leachate from each of the widely dispersed risers throughout the large facility. This cost includes transportation to the TSDF.

35. Total annual cost of removing the leachate (Line 32 x Line 33 x Line 34 x 12): The annual leachate removal cost is the product of the monthly leachate volume removed, the number of months in a year, and the unit cost per gallon removed.

36. Unit cost for removing leachates to an off-site TSDF: The unit cost for off-site disposal of the leachate material is $.05/gal. This material is disposed of in a surface impoundment.

37. Annual costs for off-site disposal (Line 32 x Line 33 x Line 36 x 12): The cost of disposing of the material in the off-site surface impoundment is the product of the amount of leachate disposed and the unit cost for the disposal.

38. Total annual cost for removing and disposing of leachates (Line 35 + Line 37): The total cost for leachate removal and disposal is the sum of the removal cost and the disposal cost.

Ground-Water Monitoring

39. Number of wells monitored: This hazardous waste facility has 12 ground-water monitoring wells. One well is upgradient and 11 wells are downgradient from the disposal area.

40. Number of samples taken per well (annual): Two "cycles" of ground-water sampling will be conducted annually. One ground-water quality analysis and two ground-water contamination analyses are to be carried out. One sample may be used for both the ground-water quality and ground-water contamination analyses. Therefore, two samples are taken from each well annually.

41. Total number of samples (annual) (Line 39 x Line 40): The total number of ground-water samples taken annually is the product of the number of monitoring wells and the number of samples taken annually from each well.

42. Number of hours for collecting the sample (per sample): Each sample requires two hours of collection time. The well must be pumped dry and allowed to refill. Then a sample is taken. The facility experience is that approximately two hours are required for each well sampling (including some time for moving about the fields).

43. Total number of hours for collecting the sample (Line 41 x Line 42): Annually, 24 samples will have to be collected, requiring 48 hours of labor.

44. Total number of hours for preparing and delivering the sample: The total number of hours required for packaging and delivering the samples is six hours per year.

45. Total sample handling hours (Line 43 + Line 44): The annual total time for collecting and delivering the ground-water samples is 54 hours.

46. Person-hour costs for handling ground-water samples: The person-hour costs for handling the samples is based on the facility experience of $15 per hour fully-loaded.

47. Total sample handling costs (Line 45 x Line 46): The total labor cost for handling the samples is the product of the hours required and the unit labor costs.

48. Unit cost of ground-water quality analysis: The unit cost of an analysis for the following parameters is $77 per analysis:

Chloride	$ 6/sample
Iron	$12/sample
Manganese	$12/sample
Phenols	$25/sample
Sodium	$12/sample
Sulfate	$10/sample

49. Unit cost of ground-water contamination analysis: The unit cost of an analysis for the following parameters is $108 per analysis:

pH	$ 4/sample
Specific Conductance	$ 4/sample
Total Organic Carbon	$25/sample
Total Organic Halogen	$75/sample

50. Total cost of ground-water quality analysis (annual) (Line 39 x Line 48): The annual cost for analysis of water quality is the product of the number of wells and the unit cost of the analysis.

51. Total cost for ground-water contamination analysis (annual) (Line 41 x Line 49): The annual cost for analysis for ground-water contamination is the product of the number of sample sets to be analyzed and the unit cost of the analysis.

52. Total annual ground-water monitoring costs (Line 49 + Line 50 + Line 51): The total annual cost for ground-water analysis is the sum of the ground-water quality analysis cost, the ground-water contamination analysis cost, and the sample handling cost.

Routine Maintenance Summation

53-60. The annual cost for each of the routine maintenance and monitoring operations are added together to yield the total cost (annual). This cost does not include administrative costs which are computed on a separate worksheet (Line 53 + Line 54 + Line 55 + Line 56 + Line 57 + Line 58 + Line 59).

C. Erosion Damage Contingency Scenario

1. Percentage of vegetation removed: Some unplanned events that will create additional demands for care will occur during the duration of the post-closure period. This worksheet computes the additional cost that would result from such an unplanned event that removes 30% of the vegetative cover from the hazardous waste facility. After the vegetation is removed, the soil remains bare for one month exposed to normal rainfall. Resulting erosive damage is repaired and the bare acreage is revegetated. The one month lapse between the damaging event and the revegetation allows for delays in the discovery of the damage and the time required for the revegetation steps.

2. Facility acreage: The entire facility is impacted by the event.

3. Acreage reduced to bare soil (Line 1 x Line 2): The acreage stripped of vegetation is the product of the percentage of vegetation removed and the total acreage of the facility.

4. Annual per acre soil loss rate (without vegetative cover): The annual soil loss for each acre of bare soil is computed using the Universal Soil Loss Equation (USLE).

$$A = RKSLCP$$

A = Average soil loss, tons/acre
R = Rainfall and run-off erosivity index
K = Soil erodibility factor
L = Slope - length factor
S = Slope - steepness factor
C = Cover/management factor (type of vegetative cover)
P = Practice factor (terracing, contour plowing)

This equation is for erosion resulting from rainfall subsequent to the event that removed the vegetation.

5. Monthly bare ground soil loss rate: The annual loss rate computed in Line 4 is converted to a one month loss rate. This conversion is accomplished by dividing the annual loss rate by 12.

6. Amount of soil lost before repairs are instituted: The amount of soil lost from the bared ground is the product of the monthly loss rate per acre and the acreage of the facility that is exposed. This product is then multiplied by two to allow for soil lost during the

removal of the vegetation. The ground is assumed to be bare for about one month before the repairs and replanting are completed. The conversion to volume of soil lost is carried out assuming a soil density of 100 lbs. per cu. ft.

7. Unit cost for excavating and loading soil: The unit cost for excavating and loading replacement soil is computed using a 2 cu. yd. front end loader. This operation will be performed under contract.

8. On-site haul of excavated soil to the area needing repair: The excavated soil is transported on-site over a 2000 ft. distance by trucks operating under contract.

9. Filling and compacting eroded areas of the facility: The replacement soil is filled and compacted into the eroded areas using a dozer operating under contract.

10. Total unit cost for replacing soil (Line 7 + Line 8 + Line 9): The total unit cost of replacing soil is the sum of the excavation-loading, hauling and filling unit costs. These unit costs were obtained from estimates made by a local contractor.

11. Cost of replacing the lost soil (Line 6 x Line 10): The total cost for replacing the lost soil is the product of the amount of soil lost times the unit cost for soil replacement.

12. Unit cost for seeding the bare soil: The unit cost for seeding the bare acreage is computed from the sum of the labor, materials and equipment costs.

Labor	$69.10/acre
Materials	$13.90/acre
Equipment	$ 5.00/acre

The grass planted is Kentucky bluegrass available from a local supplier at $0.32 per lb. in 50-lb. bags. The application rate for this seed is 1 lb. per 1000 sq. ft. (or 43.56 lbs. per acre). This is less than one-third of the seed application rate used for home lawns. Experience has shown this seeding rate to be satisfactory.

13. Unit cost for fertilizing: Since the soil at this hazardous waste facility is quite poor, fertilization is necessary. Type 10/6/4 fertilizer costing $0.12 per lb. (in 50-lb. bags) is applied at a rate of 500 lbs. per acre. This corresponds to a nitrogen application rate

of 50-lbs. per acre. The unit cost of fertilization is the sum of the labor, materials and equipment costs.

Labor	$69.10/acre
Materials	$60.00/acre
Equipment	$ 5.00/acre

Previous experience at this facility has shown that this application rate for fertilizer is satisfactory.

14. Unit cost for mulching with straw: Since the soil is bare, protection from erosion must be provided while the grass starts to grow. This is achieved by using straw mulch at an application rate of 1 ton per acre. The unit cost of mulching is the sum of the labor, materials and equipment costs.

Labor	$34.50/acre
Materials	$85.00/acre
Equipment	$ 5.00/acre

15. Total unit replanting cost (Line 12 + Line 13 + Line 14): The total unit replanting cost is the sum of the seeding, fertilizing, and mulching costs. Lime is not applied at this facility because it is not recommended by the Agricultural Extension Service (USDA).

16. Total replanting costs (Line 3 x Line 15): The total replanting cost for the facility is the product of the acreage to be replanted and the unit cost of replanting each acre.

17. Number of erosive incidents expected in the post-closure period: It is anticipated that such highly erosive incidents will occur twice during the post-closure period. These will be either major storms or floods.

18. Total cost for repairing damage from erosive incidents (Line 11 + Line 16 x Line 17): The total post-closure cost for repairing the damage from such incidents is the sum of the repair costs for each incident (soil and vegetation) multiplied by the number of incidents expected in the 30-year post-closure period.

19. Total annual cost for repairs required by erosive incidents (Line 18 ÷ 30 years): The total cost of repairing the damage from the two incidents is divided by the 30 years of the post-closure period to yield the annual cost for contingency repairs.

D. Initial Replanting to Establish Vegetation

1. Percentage failure of vegetation per year: It is estimated that in this climate, 10 percent of the vegetation will fail per year due to inadequate initial establishment.

2. Number of years required for full vegetation: It is estimated that three years will be necessary for full establishment of vegetation to the point replanting will no longer be necessary.

3. Facility acreage: Facility acreage is 200 acres.

4. Total acres to be replanted due to initial failure of vegetation (Line 1 x Line 2 x Line 3): Total acres to be replanted are then 60 acres.

5. Annual per acre soil loss: The annual soil loss for each acre of bare soil is computed using the Universal Soil Loss Equation (USLE).

$$A = RKLSCP$$

A = Average soil loss, tons/acre
R = Rainfall and run-off erosivity index
K = Soil erodibility factor
L = Slope - length factor
S = Slope - steepness factor
C = Cover/management factor (type of vegetative cover)
P = Practice factor (terracing, contour plowing)

This equation is for erosion resulting from rainfall subsequent to the event that removed the vegetation.

6. Monthly bare ground soil loss rate: The annual loss rate computed in Step 4 is converted to a one-month loss rate. This conversion is accomplished by dividing the annual loss rate by 12.

7. Amount of soil lost before repairs are instituted (Line 4 x Line 6): The amount of soil lost from the bared ground is the product of the monthly loss rate per acre and the acreage of the facility that is exposed. This product is then multiplied by two to allow for soil lost during the removal of the vegetation. The ground is assumed to be bare for about one month before the repairs and replanting are completed. The conversion to volume of soil lost is carried out assuming a soil density of 100 lbs. per cu. ft.

8. Unit cost for excavating and loading soil: The unit cost for excavating and loading replacement soil is computed using a 2 cu. yd. front end loader. This operation will be performed under contract.

9. On-site haul of excavated soil to area needing repair: The excavated soil is transported on-site over a 2000 ft. distance by trucks operating under contract.

10. Filling and compacting eroded areas of the facility: The replacement soil is filled and compacted into the eroded areas using a dozer operating under contract.

11. Total unit cost for soil replacement (Line 8 + Line 9 + Line 10): The total unit cost of soil replacement is the sum of the excavation-loading, hauling and filling unit costs. These unit costs were obtained from estimates made by a local contractor.

12. Cost of soil replacement (Line 7 x Line 11): The total cost for replacing the lost soil is the product of the amount of soil lost times the unit cost for soil replacement.

13. Unit cost for seeding bare soil: The unit cost for seeding the bare acreage is computed from the sum of the labor, materials and equipment costs.

Labor	$69.10/acre
Materials	$13.90/acre
Equipment	$ 5.00/acre

The grass planted is Kentucky bluegrass available from a local supplier at $0.32 per lb. in 50-lb. bags. The application rate for this seed is 1 lb. per 1000 sq. ft. (or about 40 lbs. per acre). This is less than one-third of the seed application rate used for home lawns. Experience has shown this seeding rate to be satisfactory.

14. Unit cost for fertilizing: Since the soil at this hazardous waste facility is quite poor, fertilization is necessary. Type 10/6/4 fertilizer costing $0.12 per lb. (in 50-lb. bags) is applied at a rate of 500 lbs. per acre. This corresponds to a nitrogen application rate of 50 lbs. per acre. The unit cost of fertilizing is the sum of the labor, materials and equipment costs.

Labor	$69.10/acre
Materials	$60.00/acre

Equipment	$ 5.00/acre

Previous experience at this facility has shown that this application rate for fertilizer is satisfactory.

15. Unit cost for mulching with straw: Since the soil is bare, protection from erosion must be provided while the grass starts to grow. This is achieved by using straw mulch at an application rate of 1 ton per acre. The unit cost of mulching is the sum of the labor, materials and equipment costs.

Labor	$34.50/acre
Materials	$85.00/acre
Equipment	$ 5.00/acre

16. Total unit replanting cost (Line 13 + Line 14 + Line 15): The total unit replanting cost is the sum of the seeding, fertilizing, and mulching costs. Lime is not applied at this facility because it is not recommended by the Agricultural Extension Service (USDA).

17. Total replanting costs (Line 4 x Line 16): The total replanting costs for the entire 30-year period are then $20,796.

18. Total costs for initial replanting to establish vegetation (Line 12 + Line 17): The total costs for the initial replanting to establish vegetation are then $20,847.

19. Total annual cost (Line 18 ÷ 30): The total cost for the initial replanting to establish vegetation is divided by the 30 years of the post-closure period to yield the total annual cost, for a total of $695.

E. Administrative Services

1. Number of technical hours required for administrative duties (annual): Since the facility is closed, all of the required administration is an extra cost that must be carefully accounted for. This facility estimates that an average of three weeks of labor by a manager is required to administer the complete set of specified post-closure activities. This average administrative requirement includes the administration of the occasional contingent events described in Worksheet C.

2. Person-hour cost for technical administrative duties: The labor rate for facility technical labor is $30 per hour fully-loaded.

3. Total administrative costs for technical labor (Line 1 x Line 2):

The total cost for administrative technical labor is the product of the hours required and the labor rate.

4. Number of clerical hours required for administrative duties: Three weeks of clerical work is required to support the technical administrator.

5. Person-hour costs for clerical administrative duties: The fully-loaded labor rate for clerical labor at the facility is $8 per hour.

6. Total administrative costs for clerical labor (Line 4 x Line 5): The total cost for administrative clerical labor is the product of the hours required and the labor rate.

7. Office or trailer rental: The total annual administrative cost also includes the rental of office space during the busier times of each post-closure year. This includes typewriter, telephone and supplies.

8. Total annual administrative costs for post-closure activities (Line 3 + Line 6 + Line 7): The total cost of administration is the sum of the costs of technical labor, clerical labor, and office rental.

F. Total Costs Including Administration and Contingencies

Items 1 through 5 summarize the total annual costs of the post-closure functions taken from the cost worksheets. The erosion contingency repair cost (Line 3) used is the annual cost of the two major erosion events expected in the post-closure period (30 years).

6. Total of Lines 1 through 5: The total costs of the activities listed in Lines 1 through 5 are $40,206.

7. Contingencies: Fifteen percent of the sum of the above costs is taken as an allowance for contingencies. This contingency allowance is made in addition to the costs expected from the two major post-closure erosion events.

8. Administration: An additional 10 percent of Line 6 is included for fees, insurance and related needs.

9. Total annual costs of post-closure (Line 6 + Line 7 + Line 8): The total sum of the annual post-closure costs is $50,258.

POST-CLOSURE

WORKSHEET A - PERIODIC FACILITY INSPECTION

1.	Number of technical management person-hours required for each routine inspection of the closed facility	16 hours
2.	Annual number of routine inspections	6
3.	Person-hour costs for technical management labor	$30
4.	Technical labor costs for annual routine inspections (Line 1 x Line 2 x Line 3)	$2880
5.	Annual number of engineer-supported inspections	2
6.	Number of independent state-certified engineering hours for each engineer-supported inspection	8 hours
7.	Number of technical management hours for each engineer-supported inspection	8 hours
8.	Person-hour cost for a professional engineer	$75
9.	Engineering labor costs for the engineer-supported inspections (Line 5 x Line 6 x Line 8)	$1200
10.	Technical labor costs for the engineer-supported inspections (Line 3 x Line 5 x Line 7)	$480
11.	Labor costs for the engineer-supported inspections (Line 9 + Line 10)	$1680
12.	Truck rental cost for each inspection	$36
13.	Annual truck rental cost for inspections (Line 2 + Line 5 x Line 12)	$288
14.	Total annual inspection cost (Line 4 + Line 11 + Line 13)	$4848

POST-CLOSURE

WORKSHEET B - ROUTINE MONITORING AND MAINTENANCE ACTIVITIES

Mowing Operations

1.	Facility acreage	200 acres
2.	Mowing labor (per acre)	$14.28
3.	Mowing equipment (per acre)	$5.37
4.	Unit mowing cost (Line 2 + Line 3)	$19.65
5.	Annual frequency of mowing	Once a year
6.	Annual cost of mowing (Line 1 x Line 4 x Line 5)	$3930

Routine Erosion Damage Repair

7.	Annual routine erosion rate	0.12 tons per acre (.089 cu. yds./acre)
8.	Total annual routine erosive loss (Line 1 x Line 7)	17.8 cu. yds.
9.	Unit cost for hand excavation of soil	$21.21/cu. yd.
10.	Unit cost for transporting of soil on-site	$2.13/cu. yd.
11.	Unit cost for hand compacting soil (repairing erosive damage)	$21.21/cu. yd.
12.	Unit cost of seeding	$1/cu. yd.
13.	Aggregate unit cost of repairing routine soil erosion damage (Line 9 + Line 10 + Line 11 + Line 12)	$45.55/cu. yd.
14.	Total annual cost for repairing erosive damage of a routine nature (Line 8 x Line 13)	$810.79
15.	Adjustment factor to account for unusually wet seasons	2
16.	Annual cost for repairing routine erosive damage (Line 14 x Line 15)	$1621.58

Fence Replacement

17.	Frequency of replacing fence	Once during post-closure period
18.	Facility perimeter	11,808 ft.
19.	Unit cost of replacing fence	$13.06/linear ft. (installed)

WORKSHEET B (continued)

20.	Total cost of fence replacement (Line 18 x Line 19)	$154,212.48
21.	Pro-rated annual cost of fence replacement	$ 5,140.41

Fertilizing

22.	Unit cost for fertilizing	$134.10/acre
23.	Number of fertilizer applications for first 3 years	3
24.	Number of fertilizer applications during remainder of post-closure (Years 4-30)	5
25.	Total costs of fertilizing for first 3 years (Line 1 x Line 22 x Line 23)	$ 80,460
26.	Total costs of fertilizing for post-closure years 4-30 (Line 1 x Line 22 x Line 24)	$134,100
27.	Total fertilizing costs (Line 25 + Line 26)	$214,560
28.	Annual cost of facility fertilization (Line 27 ÷ 30)	$ 7,152

Ground-water Monitoring Well Replacement

29.	Unit cost for replacing well	$425/well
30.	Number of wells needing replacement during the post-closure period	2
31.	Total cost of monitoring well replacement during the entire post-closure period (Line 29 x Line 30)	$850

Leachate Pumping and Disposal

32.	Frequency of removing the leachates	Once/month
33.	Average monthly total leachate withdrawal	2000 gals.
34.	Unit cost of removing the leachate to an active off-site TSDF	$0.18/gal.
35.	Total annual cost of removing leachate (Line 32 x Line 33 x Line 34 x 12)	$4320
36.	Unit cost for disposing of leachate off-site (at a surface impoundment)	$.05/gal.
37.	Annual costs for disposing off-site (Line 32 x Line 33 x Line 36 x 12)	$1200
38.	Total annual costs for removing and disposing of leachates (Line 35 + Line 37)	$5520

WORKSHEET B (continued)

Ground-Water Monitoring

39.	Number of wells monitored	12 wells
40.	Number of samples taken per well (annual)	2 samples
41.	Total number of samples per well (annual) (Line 39 x Line 40)	24 samples
42.	Number of hours for collecting the samples (per sample)	2 hours
43.	Total number of hours for collecting samples (Line 41 x Line 42)	48 hours
44.	Total number of hours for preparing and delivering samples	6 hours
45.	Total sample handling hours (Line 43 + Line 44)	54 hours
46.	Person-hour costs for handling ground-water samples	$15
47.	Total sample handling costs (Line 45 x Line 46)	$810
48.	Unit cost of ground-water quality analysis	$77
49.	Unit cost of ground-water contamination analysis	$108
50.	Total cost for ground-water quality analysis (annual) (Line 39 x Line 48)	$924
51.	Total cost for ground-water contamination analysis (annual) (Line 41 x Line 48)	$2592
52.	Total annual ground-water monitoring cost (Line 49 + Line 50 + Line 51)	$4326

Routine Maintenance Summation

53.	Annual mowing cost (Line 6)	$3930
54.	Annual cost for repairing routine erosive damage (Line 16)	$1621.58
55.	Annual cost for replacing fence (Line 21)	$5140.41
56.	Annual cost for fertilizing (Line 28)	$7152
57.	Annual cost for replacing well (Line 21 ÷ 30)	$28
58.	Annual cost for removing leachates (Line 38)	$5520
59.	Annual cost for ground-water monitoring (Line 52)	$4326
60.	Total annual cost for routine activities	$27,717.99

POST-CLOSURE

WORKSHEET C - EROSION DAMAGE CONTINGENCY SCENARIO

1.	Percentage of vegetation removed	30%
2.	Facility acreage	200 acres
3.	Acreage reduced to bare soil (Line 1 x Line 2)	60 acres
4.	Annual per acre soil loss rate (without vegatative cover)	12 tons per acre
5.	Monthly bare ground soil loss rate	1 ton per acre (.741 cu. yds./acre)
6.	Amount of soil lost before repairs are instituted (Line 3 x Line 5 x 2) (The factor of 2 adjusts for immediate soil losses)	120 tons (89 cu. yds.)
7.	Unit cost for excavating and loading soil (on-site operations using a 2-cu. yd. front end loader)	$0.21 per cu. yd.
8.	On-site haul of excavated soil to area needing repair	$0.85 per cu. yd.
9.	Filling and compacting the eroded areas (using a dozer)	$1.25 per cu. yd.
10.	Total unit cost for soil replacement (Line 7 + Line 8 + Line 9)	$2.31 per cu. yd.
11.	Cost of replacing lost soil (Line 6 x Line 10)	$205.59
12.	Unit cost for seeding the bare soil	$88/acre
13.	Unit cost for fertilizing	$134/acre
14.	Unit cost for mulching with straw	$124.50/acre
15.	Total unit replanting cost (Line 12 + Line 13 + Line 14)	$346.50/acre
16.	Total replanting cost (Line 3 x Line 15)	$20,790
17.	Number of erosive incidents expected in the post-closure period	2
18.	Total cost for repairing damage from erosive incidents (Line 11 + Line 16 x Line 17	$41,580
19.	Total annual cost for repairs required by erosive incidents (Line 18 ÷ 30)	$1386

POST-CLOSURE

WORKSHEET D - INITIAL REPLANTING TO ESTABLISH VEGETATION

1.	Percentage failure of vegetation per year	10 percent
2.	Number of years required for full vegetation	3
3.	Facility acreage	200 acres
4.	Total acres to be replanted due to initial failure of vegetation (Line 1 x Line 2 x Line 3)	60
5.	Annual per acre soil loss rate (for areas with inadequate vegetative cover)	6 tons/acre
6.	Monthly bare ground soil loss rate	.5 tons (.3706 cu. yd./acre)
7.	Amount of soil lost before repairs are instituted (Line 4 x Line 6)	30 tons (22 cu. yds.)
8.	Unit cost for soil excavation and loading (on-site operations using a 2-cu. yd. front end loader)	$0.21 per cu. yd.
9.	On-site haul of excavated soil to area needing repair	$0.85 per cu. yd.
10.	Filling and compacting eroded areas (using a dozer)	$1.25 per cu. yd.
11.	Total unit cost for soil replacement (Line 8 + Line 9 + Line 10)	$2.31 per cu. yd.
12.	Cost of soil replacement (Line 7 x Line 11)	$50.82
13.	Unit cost for seeding bare soil	$88/acre
14.	Unit cost for fertilizing	$134.10/acre
15.	Unit cost for mulching with straw	$124.50/acre
16.	Total unit replanting cost (Line 13 + Line 14 + Line 15)	$346.60/acre
17.	Total replanting costs (Line 4 x Line 16)	$20,796
18.	Total costs for initial replanting to establish vegetation (Line 12 + Line 17)	$20,847
19.	Total annual cost (Line 18 ÷ 30)	$695

POST-CLOSURE

WORKSHEET E - ADMINISTRATIVE SERVICES

1.	Number of technical hours required for administrative duties (annual)	120 hours
2.	Person-hour cost for technical administrative duties	$30
3.	Total administrative costs for technical labor (Line 1 x Line 2)	$3600
4.	Number of clerical hours required for administrative duties	120 hours
5.	Person-hour costs for clerical administrative duties	$8
6.	Total administrative costs for clerical labor (Line 4 x Line 5)	$960
7.	Office or trailer rental (includes equipment and supplies)	$1000
8.	Total annual administrative costs for the post-closure activities (Line 3 + Line 6 + Line 7)	$5560